

ENDANGERED, THREATENED, AND RARE FAUNA OF NORTH CAROLINA

Part I. A Re-evaluation of the Mammals

Edited by MARY KAY CLARK

Occasional Papers of the
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1987-3



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**in cooperation with other members
of the North Carolina Mammal Committee**

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Illustrated by Ruth Brunstetter and Renaldo Kuhler

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PART I. A RE-EVALUATION OF THE MAMMALS

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North Carolina Endangered Species Act of 1987

The accounts and other materials in the present re-evaluation of North Carolina mammals were prepared by a committee established by the North Carolina State Museum of Natural Sciences in 1985. At that time no state legislation existed to conserve and protect all native fauna. A bill to provide for conservation, management, enhancement, and protection of rare wildlife in North Carolina was ratified by the General Assembly the 16th of June 1987 and became effective the first of July 1987. Article 25, added to Chapter 113 of the General Statutes, empowers the North Carolina Wildlife Resources Commission to administrate the article and charges the Commission with adopting and publishing lists of rare fauna for the state. This legislation makes it unlawful to possess or disturb, for any reason not approved by the Commission, any animal on the protected list.

Efforts are currently under way to develop criteria and procedures for placing fauna on the protected list and to develop an official state list of protected wildlife. The North Carolina Nongame Advisory Committee advises the Commission on matters related to conservation of nongame wildlife, including the creation of protected animal lists and the development of conservation programs for species considered endangered, threatened, or of special concern.

The Advisory Committee is responsible for assembling a Scientific Council to review the biological evidence and to evaluate the threats to native wildlife. The Advisory Committee, after considering a report from the Scientific Council, may by resolution propose to the Wildlife Resources Commission that a species of wild animal be added to or removed from a protected list.

In September 1987 the Advisory Committee determined that *ad hoc* Scientific Councils should be established as needed. The Advisory Committee then appointed the mammal committee established by the North Carolina State Museum of Natural Sciences in 1985 as the first Scientific Council. This Scientific Council was charged with evaluating the status of North Carolina's mammals and providing a list of the mammals considered to be Endangered, Threatened, or of Special Concern. A report on these recommendations, with supporting documentation, was requested from the Scientific Council for presentation at the February 1988 meeting of the Advisory Committee. *A Re-evaluation of the Endangered, Threatened, and Rare Fauna of North Carolina, Part I. Mammals* is the foundation for the report of The Scientific Council on Mammals.—M.K.C.

A Re-evaluation of the Endangered, Threatened, and Rare Fauna of North Carolina

Part I. Mammals

In November 1975 the North Carolina State Museum of Natural History (now the N.C. State Museum of Natural Sciences), in cooperation with the N.C. Department of Natural and Economic Resources, the N.C. Wildlife Resources Commission, and the N.C. Academy of Science, presented a symposium on the endangered and threatened biota of North Carolina (Cooper et al. 1977). In 1985, a decade after the first symposium, the North Carolina State Museum again brought together the best available regional biological specialists to re-evaluate the status of the state's fauna. Committees were established to assess the current status of the mammals, birds, freshwater fishes, marine and estuarine fishes, reptiles and amphibians, and selected invertebrates of North Carolina. This report presents the results of the Mammal Committee's efforts. Reports from the remaining groups will be presented subsequently in the Occasional Papers of the North Carolina Biological Survey.

The category definitions have changed somewhat from those used in the 1975 symposium (see Cooper et al. 1977:x-xi). These changes were made primarily to prevent confusion with federal designations that indicate legal protection. With the exception of GS 113-189, which provides state protection for four species of sea turtles, North Carolina does not currently have state legislation that specifically addresses the protection of rare fauna. However, the Nongame and Endangered Wildlife section of the N.C. Wildlife Resources Commission has recently begun efforts to obtain such legislation (Debbie Paul, N.C. Wildlife Resources Commission, pers. comm.; see page iv).

STATUS DEFINITIONS

The categories Endangered and Threatened are applied herein only to taxa currently recognized as such under the federal Endangered Species Act of 1973. Thus, mammals designated as Endangered or Threatened on the current list are already federally listed and protected. This definition differs from that used in the 1975 symposium in that Endangered could then be applied to forms that, though perhaps common elsewhere, were clearly in danger of extirpation in North Carolina. Likewise, Threatened in the 1975 symposium applied to forms that were likely to become endangered within the foreseeable future, either within the state or

on a national level. At that time the Northern Flying Squirrel (*Glaucomys sabrinus coloratus*) was the only mammal considered in danger of extirpation within the state (Threatened) that was not on the federal list. It has since been designated Endangered under the Endangered Species Act.

To compensate for the loss of Endangered and Threatened as state-level categories, a stronger category, Vulnerable, has replaced Special Concern. This new category encompasses all North Carolina taxa judged to be, within the state, in danger of extirpation as well as those forms whose numbers have decreased beyond the normal fluctuation to an extent that, if unmanaged, they may become in danger of extirpation. Additionally, Vulnerable includes taxa that either exist in low numbers over a relatively broad range or possess characteristics or ecological requirements that make them susceptible to specific pressures.

The Vulnerable category combines organisms that are all known to be locally rare and in need of attention, but there is considerable variation in both the level of concern and the degree of protection needed. For instance, both the Black Bear and the Coastal Plain race of the Eastern Wood Rat are listed in this category. The Black Bear is a game species whose populations are regularly monitored and managed by the N.C. Wildlife Resources Commission. Although the total range has been greatly reduced, this is a widely distributed species in North America. In contrast, there is evidence that the Coastal Plain race of the Eastern Wood Rat, a nongame mammal, may have become extirpated from this region of North Carolina. It has not been managed, monitored, or protected. This mammal is restricted to eastern North America, and populations in other parts of its range may also be declining (see Federal Register, Vol. 50, No. 181, p. 37962). Because there is so much variation in this category, readers are urged to read carefully the "Rationale for Evaluation" sections in accounts for Vulnerable mammals.

Because adequate information is lacking to make a status determination, some taxa that are potentially Vulnerable, Threatened, or Endangered are listed as Undetermined. This category represented the bulk of the taxa in the original list (Table 1). Twenty-four mammals were designated Undetermined in 1975. Fourteen

TABLE 1. Status of North Carolina mammals other than those considered common in 1975 (from Cooper et al. 1977) and in 1985 (exclusive of the Cetacea and Pinnipedia).

Taxa	Status - 1975	Status - 1985	Taxa	Status - 1975	Status - 1985
Insectivora:			Lagomorpha:		
<i>Sorex longirostris fisheri</i>	Undetermined	Threatened	<i>Sylvilagus transitionalis</i>	Undetermined	Undetermined
Dismal Swamp Southeastern Shrew			New England Cottontail		
<i>Sorex palustris punctulatus</i>	Undetermined	Undetermined	<i>Sylvilagus aquaticus</i>	(not known from N.C. in 1975)	Undetermined
Water Shrew			Swamp Rabbit		(removed)
<i>Sorex dispar blitchi</i>	Undetermined	Undetermined	<i>Lepus americanus virginianus</i>	Undetermined	
Long-tailed Shrew			Snowshoe Hare		
<i>Sorex hoyi winnemana</i>	Undetermined	Undetermined	Rodentia:		
Pygmy Shrew			<i>Sciurus niger niger</i>	Undetermined	Vulnerable
<i>Blarina brevicauda telmalestes</i>	Undetermined	(removed)	Fox Squirrel		(Coastal Plain)
Dismal Swamp Short-tailed Shrew			<i>S. niger</i> ssp.?	Undetermined	Vulnerable
<i>Parascalops breweri</i>	Undetermined	(removed)	Fox Squirrel		(Mountains - Extirpated?)
Hairy-tailed Mole					Endangered
<i>Condylura cristata parva</i>	(not listed)	Undetermined	<i>Glaucomys sabrinus colaratus</i>	Threatened	
Star-nosed Mole			Northern Flying Squirrel		
Chiroptera:			<i>Neotoma floridana floridana</i>	Undetermined	Vulnerable
<i>Myotis lucifugus lucifugus</i>	Undetermined	(removed)	Eastern Wood Rat	(not listed)	(Extirpated?)
Little Brown Myotis			<i>N. f. haematorieia</i>		Undetermined
<i>Myotis austroriparius austroriparius</i>	Undetermined	(removed)	Eastern Wood Rat	(not listed)	Undetermined
Southeastern Myotis			<i>N. f. magister</i>		
<i>Myotis grisescens</i>	Undetermined	(removed)	Eastern Wood Rat	Undetermined	Undetermined
Gray Myotis			<i>Microtus chrotorrhinus carolinensis</i>		
<i>Myotis keenii septentrionalis</i> *	Undetermined	(removed)	Rock Vole		
Keen's Myotis			<i>Microtus pennsylvanicus nigrans</i>	Undetermined	(removed)
<i>Myotis sodalis</i>	Endangered	Endangered	Dismal Swamp Meadow Vole		
Indiana Bat			<i>Synaptomys cooperi helaletes</i>	Undetermined	(removed)
<i>Myotis leibii leibii</i>	Undetermined	(removed)	Southern Bog Lemming		
Small-footed Myotis			<i>S. c. stonei</i>	Undetermined	(removed)
<i>Lasiurus seminolus</i>	Undetermined	(removed)	Southern Bog Lemming		
Seminole Bat			Carnivora:		
<i>Plecotus townsendii virginianus</i>	(not known from N.C. in 1975)	Endangered	<i>Ursus americanus</i>	Special Concern	Vulnerable
Virginia Big-eared Bat			Black Bear		
<i>Plecotus rafinesquii macrootis</i>	Undetermined	Vulnerable	<i>Mustela nivalis allegheniensis</i>	Undetermined	(removed)
Rafinesque's Big-eared Bat			Least Weasel		
<i>P. r. rafinesquii</i>	(not listed)	Vulnerable	<i>Felis concolor</i>	Endangered	Endangered
Rafinesque's Big-eared Bat			Panther	(Extirpated?)	
<i>Tadarida brasiliensis cynocephala</i>	Undetermined	(removed)	Sirenia:		
Brazilian Free-tailed Bat			<i>Trichechus manatus</i>	Endangered	Endangered
			Florida Manatee		

* Two subspecies of *M. keenii* are recognized. *keenii* (western North American populations) and *septentrionalis* (eastern North American populations). Recent data indicate that these forms represent two species, *M. keenii* and *M. septentrionalis* (C. G. van Zyll de Jong 1985, Handbook of Canadian Mammals, Vol. II: Bats, National Museum of Canada, p. 90).

of these were removed, largely due to increased field effort conducted in the intervening decade.

CHANGES IN STATUS

Although a thorough systematic review of *Blarina* sp. is needed before the true distribution and abundance of *Blarina brevicauda telmalestes* can be determined, French (1981) and Clark et al. (1985) present evidence that this race is not as geographically restricted as was previously believed. The Hairy-tailed Mole (*Parascalops breweri*) reaches the southern limit of its range in the North Carolina mountains but is relatively common there (Lee et al. 1982). It is not restricted to any one particular vegetational type or successional stage. The paucity of records for the state is probably an artifact of trapping difficulties.

The distribution of the Little Brown Bat (*Myotis lucifugus*) is still not well known in the state. This is an abundant, wide-ranging species in North America, and it is not thought to be in need of protection. In 1975 the Southeastern Myotis (*M. austroriparius*) was known from only one individual, assumed to be a vagrant, from New Hanover County (Lee et al. 1982). The discovery of a colony in Wake County and survey work conducted in New Hanover County by William F. Adams, U.S. Army Corps of Engineers, indicate this bat is a relatively common resident of eastern North Carolina.

The status of two other *Myotis* is not clear. Additional records of both the Small-footed Bat (*M. leibii*) and Keen's Myotis (*M. keenii*) were obtained in the past decade. However, Michael Harvey, of Tennessee Technological University (pers. comm.), recently expressed concern about the status of both of these species in the eastern United States. Neither species appears to be common in North Carolina. Robert Currie, Endangered Species Office, U.S. Fish and Wildlife Service (pers. comm.), recently reported (March 1987) finding a large colony of *M. keenii*, and several individuals of this species have been mist-netted in the northwestern mountains (NCSM records). In spite of increased field effort in the mountains, our records of the Small-footed Bat are still few. This bat has a wide range in North America; but a hiatus occurs in the central United States, and the distribution in the East is discontinuous. The Eastern Small-footed Bat is listed as Category 2 by the U.S. Fish and Wildlife Service (Federal Register, Vol. 50, No. 181, p. 37965). Although not included in the following list, both of these bats, particularly the Small-footed Bat, need further attention.

Two other bats were removed from the list, the Seminole Bat (*Lasiurus seminolus*) and the Brazilian Free-tailed Bat (*Tadarida brasiliensis*). William F. Adams, (pers. comm.) reported collecting many Seminole Bats in southeastern North Carolina, and Clark et al. (1985) briefly discuss the ecological distribution of the species in the state. Lee and Marsh (1978) documented a range expansion for the Brazilian Free-tailed Bat. Additionally, in the summer of 1986, a new roost

site was discovered in Bladen County by NCSM staff members. The presence of these bats was confirmed in December, March, and July, indicating that they are year-round residents in the state (NCSM records).

Two mammals listed in 1975, the Gray Bat (Endangered) and the Snowshoe Hare (Undetermined), are not thought to be residents in the state. The Gray Bat (*Myotis grisescens*) is known from one banded individual found in Buncombe County (Tuttle and Robertson 1969). Because this locality is outside of the known range, the bat is assumed to have been a vagrant (Lee et al. 1982).

The Snowshoe Hare (*Lepus americanus*) was included in the 1975 list because North Carolina appeared to be within its historic range and rumors of its presence in spruce-fir areas in the state persisted (Lee and Funderburg in Cooper et al. 1977:405). There is no substantial evidence that this species occurs in the state, so it has been removed from the list.

The Dismal Swamp race of the Meadow Vole (*Microtus pennsylvanicus nigrans*) was found to be widespread in the northeastern Coastal Plain (Clark et al. 1985) and was abundant where trapped. Rose (1981) rediscovered the Dismal Swamp race of the Southern Bog Lemming (*Synaptomys cooperi helaletes*), which had not been found since 1896. Additional specimens (Clark et al. 1985) indicate the race is more widespread geographically than was previously expected. Peter Weigl (pers. comm.) reported that he often traps bog lemmings in western North Carolina and that they seem to be common in appropriate habitats.

The Least Weasel (*Mustela nivalis allegheniensis*) was known from four localities in 1975. The small number of records is thought to be the result of a lack of field effort and not a true reflection of the abundance of the species in the state. In the early 1980s two researchers, David Adams (N.C. State University) and William T. Sullivan (N.C. State University, Agricultural Research Service), independently trapped several Least Weasels in western North Carolina.

DISCUSSION

The present inventory of rare mammals comprises 21 species or subspecies as opposed to the 29 presented in the 1975 symposium (Table 2). A comparison of the total taxa listed in 1975 and at present may give a first impression that the overall status of North Carolina's

TABLE 2. Comparison of the number of mammal taxa considered rare in North Carolina in 1975 (Cooper et al. 1977:390-391) and currently designated as such. See page 1 of the text for category definitions.

	1985	1975
Endangered	5	3
Threatened	1	1
Special Concern	6	1
Vulnerable	9	24
Undetermined	21	29
Total Listed		

mammal fauna has improved. Closer inspection reveals that this is not the case.

The status of five of the ten taxa remaining on the list as Undetermined did not change. The other five previously listed as Undetermined are now considered to be either Vulnerable or Threatened. The number of Endangered taxa increased by two, and the number Threatened remains at one. The most change occurred in the Special Concern/Vulnerable category, which increased from one to six mammals. Overall, six mammals were added to the list and fourteen were removed. Two of the additions, *Plecotus townsendii virginianus* and *Sylvilagus aquaticus*, were not known from the state when the 1975 symposium was held.

With the exception of the Chiroptera, the number of taxa represented in each Order remains about the same as in the previous list. In 1975 nine bats were listed because of the paucity of data available for this group of mammals in the state. Knowledge of our bat fauna increased dramatically, and only four taxa are now listed (but see comments on *M. leibii* and *M. keenii*). It should be noted, however, that all bats now listed are in more serious levels of concern than those assigned to them in 1975.

Several important threats to all bats should be mentioned. The destruction of roost sites, disturbances (particularly of hibernacula and nursery colonies), chemical contaminants, and direct killing have all been implicated in documented declines of bat species in the United States. Since colonial bats often concentrate large numbers of the total population in only a few sites, destruction of the roost, or other harmful disturbances, can result in the loss of a significant portion of the total population.

Bats are one of the least studied of all mammal groups. More information is needed on all aspects of their life history and ecology in order to formulate effective management plans. Important hibernacula and maternity roosts for bat species—those listed and some that are not—should be located and monitored regularly in an effort to prevent further declines in bat populations in the state.

Marine mammals, with the exception of the manatee (*Sirenia: Trichechus manatus*), which occurs in estuarine and freshwater coastal systems in the state, were not included in this report or in the 1975 list. The two seals, Harbor Seal (*Phoca vitulina*) and Hooded Seal (*Cystophora cristata*), occur in the state on an irregular basis and are assumed to be vagrants.

The complexities involved in field studies of Cetaceans, combined with the fact that they are wide-ranging, pelagic animals, make it difficult to determine the regularity of their occurrence in North Carolina's offshore waters. Because so little is known of their local seasonal occurrence and abundance, statements regarding their status in North Carolina would be premature. Problems contributing to reductions in numbers of marine mammals must be addressed on broader levels.

The Marine Mammal Act of 1972 was passed for this reason and offers full protection for all marine mammals. Additional federal protection is provided for some Cetaceans by the Endangered Species Act of 1973.

Previously, most of our knowledge of North Carolina's marine mammals has come primarily from strandings. Strandings are generally not representative of the diversity and abundance of marine mammals. The N.C. State Museum has been conducting studies of pelagic birds off the North Carolina coast for the past decade and has accumulated much information on the marine mammal fauna as well. The museum is currently summarizing oceanic records that, combined with data from coastal strandings, will greatly improve our understanding of the state's marine mammal fauna. A list of the Cetacea occurring off the North Carolina coast is provided in Table 3.

Currently, attempts to re-introduce the Red Wolf (*Canis rufus*), an Endangered species, into North Carolina are under way. This work illustrates the effort needed to re-establish critically rare taxa and indicates that early recognition and implementation of research and management plans that ensure viable, self-sustaining populations are preferred. Red Wolf populations had become so reduced rangewide that complete recovery of the species could only be accomplished by removing all Red Wolves from the wild. A captive breeding program was then established so that a pure genetic stock would be available for eventual re-establishment of a self-sustaining population in the wild. Recently, the Alligator River Wildlife Refuge in Dare County, N.C., was selected as the first release site for Red Wolves in the attempt to fulfill one of the primary goals of the Endangered Species Act, to restore Endangered and Threatened animals and plants to the point where they are again secure, self-sustaining members of their ecosystems.

We cannot settle for hindsight in dealing with matters such as the near extinction of the Red Wolf. Periodic review of rare taxa and a constant awareness of the workings of natural systems are necessary to maintain faunal diversity and to prevent the immeasurable losses that occur to whole ecosystems when forms become extirpated or extinct. The primary goal of the 1975 symposium (Cooper et al. 1977) was to guide and stimulate research on listed species in order to prevent such occurrences. Much has been learned about the state's mammal fauna in the past decade, but gaps still remain. Information regarding distribution, population biology, and other aspects of life history is needed to protect and maintain viable populations of many of the mammals discussed. The purpose of this report, then, is not only to upgrade our knowledge of rare mammals in the state, but also to further encourage researchers and governmental agencies to initiate and implement programs that will ensure the viability of the taxa listed.

TABLE 3. Checklist of cetaceans known from North Carolina waters (Lee et al. 1982).

ORDER CETACEA

Family Balaenopteridae

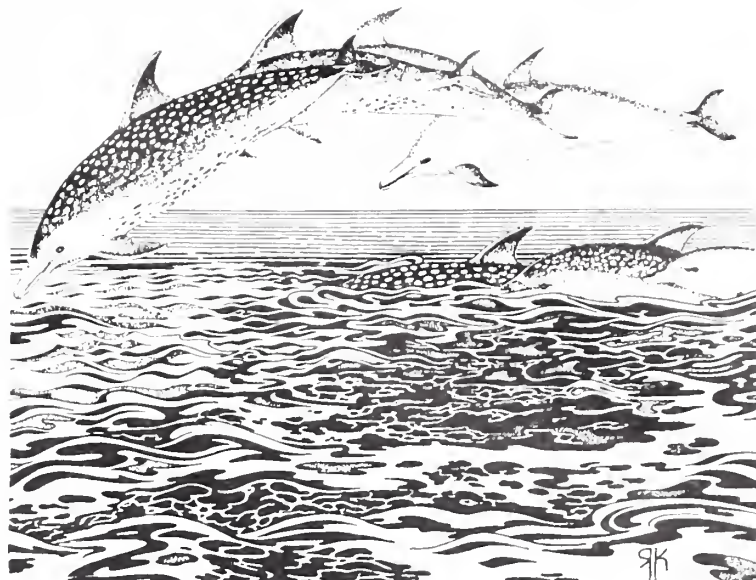
- Balaenoptera acutorostrata* Lacepede
Minke Whale
- Balaenoptera borealis* Lesson
Sei Whale
- Balaenoptera physalus* (Linnaeus)
Fin Whale
- Megaptera novaeangliae* (Borowski)
Humpback Whale

Family Balaenidae

- Balaena glacialis* Müller
Black Right Whale

Family Delphinidae

- Steno bredanensis* (Lesson)
Rough-toothed Dolphin
- Tursiops truncatus* (Montagu)
Atlantic Bottlenosed Dolphin
- Grampus griseus* (G. Cuvier)
Risso's Dolphin or Grampus
- Stenella longirostris* (Gray)
Spinner Dolphin
- Stenella frontalis* (G. Cuvier)
Bridled Spotted Dolphin
- Stenella coeruleoalba* (Meyen)
Striped Dolphin
- Delphinus delphis* Linnaeus
Saddleback Dolphin
- Pseudorca crassidens* (Owens)
False Killer Whale
- Globicephala melas* (Traill)
Long-finned Pilot Whale
- Globicephala macrorhynchus* Gray
Short-finned Pilot Whale
- Orcinus orca* (Linnaeus)
Killer Whale



Family Phocoenidae

- Phocoena phocoena* (Linnaeus)
Harbor Porpoise

Family Ziphiidae

- Ziphius cavirostris* G. Cuvier
Goosebeaked Whale
- Mesoplodon europaeus* (Gervais)
Gervais' Beaked Whale
- Mesoplodon densirostris* (Blainville)
Dense-beaked Whale
- Mesoplodon mirus* True
True's Beaked Whale

Family Kogiidae

- Kogia breviceps* (Blainville)
Pygmy Sperm Whale
- Kogia simus* (Owen)
Dwarf Sperm Whale

Family Physeteridae

- Physeter macrocephalus* Linnaeus
Sperm Whale

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Jeff Beane, N.C. State Museum, assisted in the preparation of distribution maps, and Ruth Brunstetter illustrated the external diagnostic characters for taxa discussed in the accounts. The skull illustration for *Sylvilagus transitionalis* was prepared by Renaldo Kuhler of the N.C. State Museum. David S. Lee

reviewed this manuscript, and his suggestions greatly improved it.

LITERATURE CITED

- Clark, M. K., D. S. Lee, and J. B. Funderburg, Jr. 1985. The mammal fauna of Carolina bays, pocosins, and associated communities in North Carolina: an overview. *Brimleyana* 11:1-38.
- Cooper, J. E., S. S. Robinson, and J. B. Funderburg (editors). 1977. *Endangered and Threatened Plants and Animals of North Carolina*. N.C. State Mus. Nat. Hist., Raleigh.
- French, T. W. 1981. Notes on the distribution and taxonomy of Short-tailed Shrews (Genus *Blarina*) in the Southeast. *Brimleyana* 6:101-110.
- Lee, D. S., J. B. Funderburg, Jr., and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. Occas. Pap. N.C. Biol. Surv.

- Lee, D. S., and C. Marsh. 1978. Range expansion of the Brazilian Free-tailed Bat into North Carolina. *Amer. Midl. Nat.* 100:240-241.
- Rose, R. K. 1981. *Synaptomys* not extinct in the Dismal Swamp. *J. Mammal.* 60:844-845.
- Tuttle, M. D., and P. B. Robertson. 1969. The Gray Bat, *Myotis grisescens*, east of the Appalachians. *J. Mammal.* 50:370.

Prepared by MARY KAY CLARK

FEDERALLY ENDANGERED

Myotis sodalis Miller and Allen INDIANA BAT

Description. Adults of the genus *Myotis* are generally the smallest bats encountered in North Carolina, with only Eastern Pipistrelles (*Pipistrellus subflavus*) and juveniles of other species being smaller. Bats of the genus *Myotis* can best be distinguished from other North Carolina bats by their dentition. All *Myotis* have a dental formula of 2/3, 1/1, 3/3, 3/3; no other North Carolina genus of bats shares this formula. The dorsal fur of Indiana Bats is brown in color (Hall 1962). The ventral fur is lighter with a slight cinnamon cast. As with most bats, fur color is variable and should not be used alone for identification purposes.

The Indiana Bat is most frequently and easily confused with the Little Brown Bat, *Myotis lucifugus*. Several key features separate these two species (Fig. 1). The Indiana Bat has a keeled calcar, short toe hairs, fur that is not glossy, and a light-colored nose. The Little Brown Bat has a calcar that is not keeled, long toe hairs, glossy fur, and a dark-colored nose. Barbour and Davis (1969) and Hall (1962) provide excellent descriptions of the Indiana Bat and additional information on distinguishing it from the Little Brown Bat.

Range. The range of the Indiana Bat is centered on the cavernous limestone areas of the eastern United States (Fig. 2). Its winter distribution is fairly well known through studies of hibernacula. Major hibernacula occur in Kentucky, Indiana, and Missouri (USFWS 1983). The summer range is not well known, and our understanding of it is obscured by records of wandering individuals. Indiana Bats are generally considered to range from the western edge of the Ozark Mountains in Oklahoma north to southern Wisconsin, east to Vermont, and south down the Appalachian Mountains to northern Alabama. One apparently vagrant specimen was taken in northern Florida (Jennings and Layne 1957).

In North Carolina, the Indiana Bat has been recorded from four locations, all in the mountains (Adams 1950, Hall 1962, Lee et al. 1982). Few caves in the state offer suitable habitat for summer or winter roosts, and no significant hibernacula are known. No attempts have been made to determine the seasonal distribution of the species in the state. There are

published North Carolina records for the summer and winter (Hall 1962) and for the fall (Adams 1950). This bat probably is more widespread in the state during the summer months than records indicate.

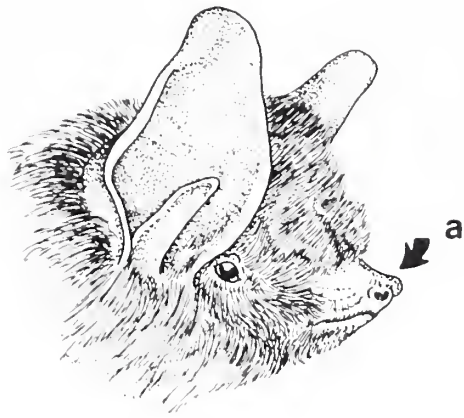
Habitat. The Indiana Bat has winter and summer habitat requirements that differ markedly. Winter habitat, which consists primarily of hibernacula in caves and abandoned mines, has been studied fairly extensively. It is from hibernacula that most of our specimens and knowledge of this species originate. Indiana Bats enter their hibernacula between mid-September and early November and reside there with only occasional periods of activity until exiting between mid-March and early May (Hall 1962). Hibernation occurs only in zones where midwinter temperatures are stable and range between 4 and 8 °C (USFWS 1983). Detailed discussions of Indiana Bat hibernacula and hibernation are found in Hall (1962) and the U.S. Fish and Wildlife Service Recovery Plan (1983) for the species.

During the summer months the majority of Indiana Bats using caves are males, usually averaging greater than 80% by number (Hall 1962). Most males, however, also leave the caves during the summer months. The distribution and habitat of these summer males is unknown. They probably disperse throughout the range of the species and spend the summer foraging alone over streams or along forest margins. Females leave the hibernacula to form maternity colonies containing between 50 and 100 individuals (Humphrey et al. 1977, USFWS 1983). Few maternity colonies have been located to date, and this important aspect of the species' life history is just beginning to be understood. Maternity colonies have been found under loose bark on dead or living trees in riparian areas along small- to medium-sized streams. Humphrey et al. (1977) suspected that dead trees may be preferred because the absence of foliage permits the bark to become warmer than that of living trees.

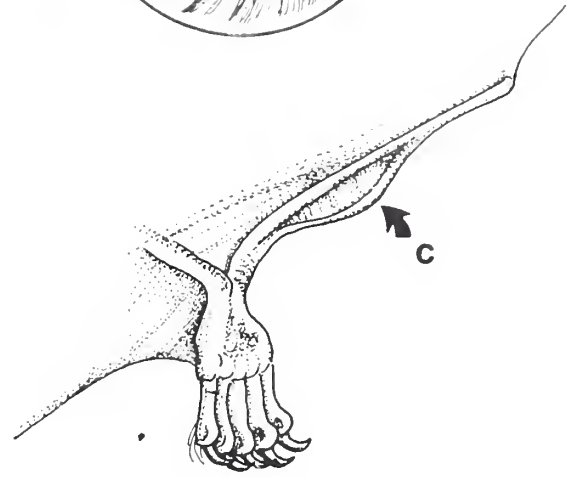
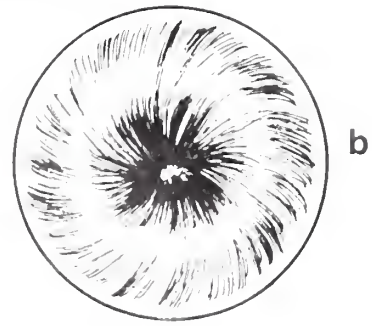
Hall (1962) stresses the importance of rivers as foraging areas and migration corridors for the species. Optimum foraging habitat for Indiana Bats appears to be over streams with mature riparian vegetation overhanging the water by more than 3 m (USFWS 1983). Streams that have had their riparian vegetation removed do not appear to offer suitable foraging habitat.

Life History and Ecology. Indiana Bats have been called "cluster bats" because of the large aggregations they form during hibernation. These clusters are irregularly shaped and are usually formed on the flat surfaces of the walls and ceilings of caves. The location of these clusters within each hibernaculum appears to be stable through time (Hall 1962).

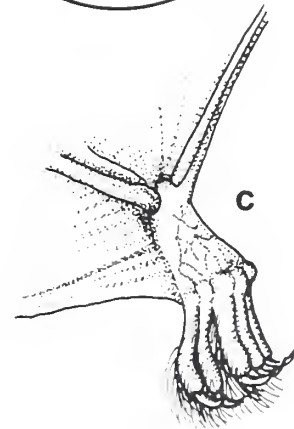
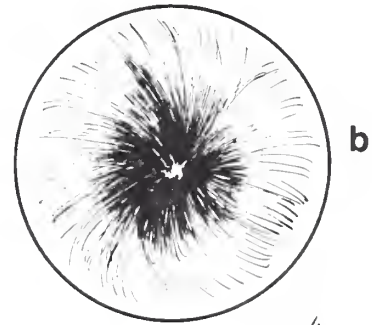
Swarming at the entrances to hibernacula typically occurs during the fall. This behavior is believed to be important in facilitating mate-finding, familiarizing young with hibernacula, and preventing inbreeding (Cope and Humphrey 1977).



Myotis sodalis



Myotis lucifugus



ЯТБ

Fig. 1. *Myotis sodalis* (top) can be distinguished from *M. lucifugus* (bottom) by several external characters: (a) the nose of *lucifugus* is dark, the nose of *sodalis* often appears pink; (b) *lucifugus* has bicolored fur, *sodalis* has tricolored fur; and (c) hairs extend beyond the toes in *lucifugus* but do not in *sodalis*. Additionally, the calcar is keeled in *sodalis*.

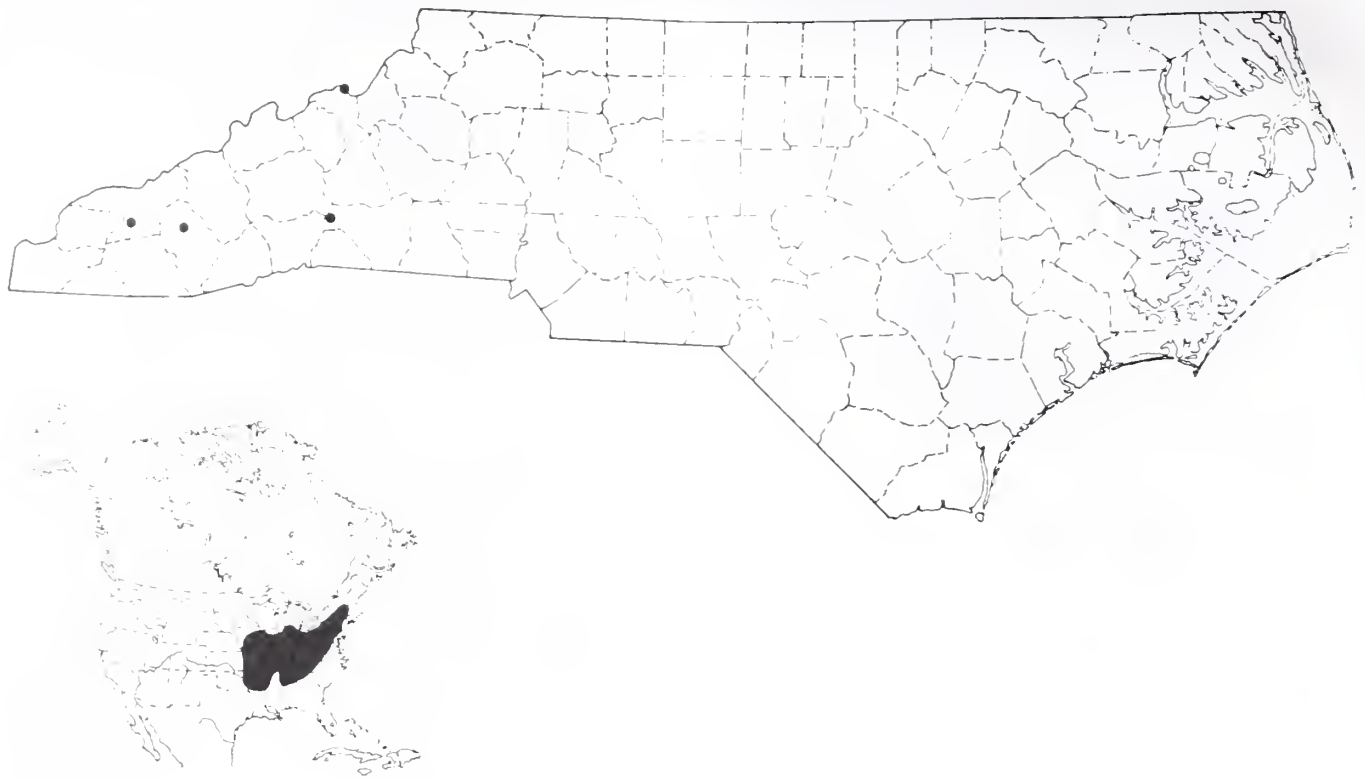


Fig. 2. The known distribution of *Myotis sodalis* in North Carolina and its range in North America.

Female Indiana Bats enter hibernation shortly after mating in the fall. Hall (1962) noted some reproductive activity through the winter and in late spring as the bats were leaving hibernacula. Females are thought to store sperm through the winter, with ovulation, fertilization, and implantation occurring after emergence from hibernation (Thomson 1982). Single young are usually born in June or early July (Humphrey et al. 1977, USFWS 1983).

Indiana Bats are thought to have long life spans. The maximum recorded age is that of an individual recovered 20 years after it was banded as an adult (LaVal and LaVal 1980). Humphrey and Cope (1977) recorded individuals living in excess of 12 years. Humphrey et al. (1977) estimated an 8% mortality rate for young between birth and weaning. Thomson (1982) notes that nothing is known about the gestation period, prenatal development, prepubertal development, or age at maturity for the species.

Known predators are Screech Owl (Humphrey et al. 1977), Mink (Goodpaster and Hoffmeister 1950), and Black Rat Snake (Barr and Norton 1965). Parasites include mites and trematodes (Thomson 1982).

Special Significance. North Carolina is on the periphery of the range of this species, and its Indiana Bat population is very poorly known. Research in progress in the state may provide insights on dispersal of summer males and may disclose the presence of maternity colonies (M.K. Clark, pers. comm.).

Status. Federally Endangered (32 FR 4001, 11 March 1967).

Rationale for Evaluation. Although the North Carolina population is almost unknown, scant available information indicates that numbers in the state are probably very low. The species continues to be vulnerable because of its low population numbers and its reliance on very few hibernacula. A range-wide census conducted during the winter of 1980-1981 revealed a total population of 554,900 bats (USFWS 1983). At present, approximately 85% of the total population winters in just seven hibernacula, with almost half wintering in just two (USFWS 1983). These concentrations leave the species extremely vulnerable to disturbance or to catastrophic natural events such as flooding or ceiling collapse. Hall (1962) describes an instance when the flooding of a Kentucky cave in 1937 resulted in the death of an estimated 300,000 Indiana Bats. Ceiling collapse is currently a concern at an abandoned mine in Missouri that presently harbors the largest known Indiana Bat hibernaculum (USFWS 1983). Other threats to the species include disturbance of hibernating individuals by man, deforestation of riparian areas of streams (Humphrey et al. 1977), removal of dead trees that may be suitable as nursery trees, and pesticide poisoning (USFWS 1983).

Current Protection. The Indiana Bat has been listed as endangered throughout its range since 1967 and is currently protected under the Endangered Species

Act. A recovery plan for the species was approved by the U.S. Fish and Wildlife Service in 1983. Management efforts have been directed principally toward protection of important hibernacula and are being undertaken by the U.S. Fish and Wildlife Service, state conservation agencies, and citizens' groups.

In North Carolina, Bat Cave, where *M. sodalis* has been observed, is being managed by the Nature Conservancy. A large portion of the potential summer habitat for this species in North Carolina is currently in federal ownership either in National Forests (Pisgah, Nantahala, and Cherokee) or in the Great Smoky Mountains National Park. The key to the future success of the species in North Carolina may depend in large measure on how the riparian areas within these lands are managed.

Recommendations. Studies are needed to determine the seasonality, abundance, distribution, reproduction, and ontogeny of this species in North Carolina. Good baseline data need to be developed to aid in determining recovery potential and population trends. Limiting factors, once identified, should be used in preparing recommendations for site-specific or regional management procedures. Because almost all North Carolina records occur in the Little Tennessee River drainage, initial survey efforts would probably be most fruitful along the water courses of that area.

LITERATURE CITED

- Adams, David A. 1950. *Myotis subulatus leibii* in North Carolina. J. Mammal. 31:97-98.
- Barbour, R. W., and W. H. Davis. 1969. Bats of America. Univ. Press Kentucky, Lexington.
- Barr, T. C., Jr., and R. M. Norton. 1965. Predation on cave bats by the pilot black snake. J. Mammal. 46:672.
- Cope, J. B., and S. R. Humphrey. 1977. Spring and autumn swarming behavior in the Indiana Bat, *Myotis sodalis*. J. Mammal. 58:93-95.
- Goodpaster, W., and D. F. Hoffmeister. 1950. Bats prey for Mink in Kentucky cave. J. Mammal. 31:457.
- Hall, J. S. 1962. A life history and taxonomic study of the Indiana Bat *Myotis sodalis*. Reading Pub. Mus. and Art Gallery, Sci. Publ. 12:1-68.
- Humphrey, S. R., and J. B. Cope. 1977. Survival rates of the endangered Indiana Bat, *Myotis sodalis*. J. Mammal. 58:32-36.
- Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. Summer habitat and ecology of the endangered Indiana Bat, *Myotis sodalis*. J. Mammal. 58:334-346.
- Jennings, W. L., and J. W. Layne. 1957. *Myotis sodalis* in Florida. J. Mammal. 38:259.
- LaVal, R. K., and M. L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave dwelling species. Missouri Dept. Conservation, Terrestrial Series 8:1-53.
- Lee, D. S., J. B. Funderburg, and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. Occas. Pap. N.C. Biol. Surv.
- Thomson, C. E. 1982. *Myotis sodalis*. Mammal. Species 163:1-5.
- U.S. Fish and Wildlife Service. 1983. Recovery plan for the Indiana Bat.

Prepared by WILLIAM F. ADAMS

Plecotus townsendii virginianus (Handley) VIRGINIA BIG-EARED BAT

Description. This is one of two species of big-eared bats (see also *Plecotus rafinesquii*) that occur in the state. The long ears, more than 2.5 cm long (1 inch), are more than twice as long as those of other North Carolina bats, and are the most obvious distinguishing feature of this genus. The ears are held erect when the bat is awake but are curled beside the head when the bat is in hibernation or at rest in a summer roost (Fig. 3). Large glandular masses on the muzzle are also distinctive.

Although easily confused, *P. townsendii* and *P. rafinesquii* are distinguished by several external features (Fig. 4). Dorsal fur is dark brown with little color change from the tips to the bases of the fur in *P. townsendii*. The underparts are also brown, although generally lighter than the dorsal fur. The dorsal fur of *P. rafinesquii* is slate gray, and the underparts are white with dark bases. Thus, an overall brown color is observed in *P. townsendii*, and *P. rafinesquii* appears bicolored. Additionally, the hairs on the toes of *P. rafinesquii* extend beyond the toenail, but they do not in *P. townsendii*. Average measurements (in mm) of 10 adult female *Plecotus townsendii* from West Virginia are: total length 103 (99-112), tail vertebrae 49 (46-54), hind foot 12 (11-13), ear (from notch) 35 (34-39), and forearm 45.8 (44.6-47.4). Kunz and Martin (1982) provided a review of the species; see also Handley (1959) for a generic revision.

Range. While the species is widespread in the western United States, the range of the eastern subspecies, *P. t. virginianus*, is fragmented into several populations (Fig. 5). The most extensive of these is in a dozen or more caves in tributaries of the Potomac River in eastern West Virginia and in tributaries of the James River in Virginia. Isolated populations are found in Tazewell County, Va., and in Lee County, Ky. The present distribution of relict populations is thought to reflect the influence of post-Pleistocene climates (Handley 1959, Humphrey and Kunz 1976). The type locality of *Plecotus townsendii virginianus* is Schoolhouse Cave, 4.4 miles northeast of Riverton, 2205 feet. Pendleton County, W.Va.

The Virginia Big-eared Bat was not known in North Carolina until the early 1980s (Clark and Lee 1987). An initial investigation of the distribution of this bat in the state began in 1984 and will terminate in the fall of 1987. In North Carolina, this bat is known only



Fig. 3. The large ears, measuring more than an inch in length, and the lumps on the snout separate *Plecotus* spp. from other North Carolina bats. At rest the ears are curled about the head and neck, but the tragi remain erect.

from Avery and Watauga counties. Preliminary results from the current study suggest that the range is confined to this area and that populations are small.

Habitat. The Virginia Big-eared Bat uses only caves or mines as summering and wintering sites. Maternity colonies, which form in the spring, require warm caves. Hibernating colonies are typically located deep within caves in passageways having considerable air movement and stable temperatures. The temperature in *P. townsendii* hibernacula is often lower than that tolerated by other cave bats. *Plecotus townsendii* have been found hibernating in temperatures ranging from 6.0 to 12.0 °C (Bagley 1984). The species exhibits a high degree of site fidelity (Humphrey and Kunz 1976). Alternate roost sites may be used, but no long migrations have been recorded for this species (Barbour and Davis 1969). Roost sites are generally found in caves or mines occurring in oak-hickory forests. Foraging habitat has not been adequately identified.

Life History and Ecology. Normally emerging after dark, *P. townsendii* feed principally on small moths (Kunz and Martin 1982). There is some discrepancy as to whether these bats are gleaners as reported by Howell (1920). Bell (in Kunz and Martin 1982) observed *P. townsendii* feeding mostly in the air along forest edges and suggested they should not be considered foliage gleaners.

As with most colonial, temperate bats, the females form maternity colonies in the spring and summer. In winter mixed groups hibernate either in clusters or singly (Kunz and Martin 1982). They hang from open ceiling and do not roost in cracks or crevices as some species do.

Reproduction. Mating begins in the fall and peaks between November and February. Young females are reproductively active by their first autumn. Females

produce only one young in the spring. The young grow rapidly, reaching adult size in about 1 month (summarized from Kunz and Martin 1982).

Special Significance. The occurrence of *P. t. virginianus* in North Carolina extends the known range for this subspecies south by 118 km.

Status. Federally Endangered (44 FR 69208, 30 November 1979).

Rationale for Evaluation. Rationale for this determination was the small population size in the state, the fragmented distribution of populations in the eastern United States, vulnerability to human disturbance, and a documented decline in numbers throughout the range.

Current Protection. The USFWS declared the Virginia Big-eared Bat an endangered species in 1979 under the Endangered Species Act of 1973. In the fall of 1986 a gate was installed at the only known hibernaculum for this bat in North Carolina to protect this colony from human disturbance. All known populations are monitored on a regular basis, and the biological effects of gating roost entrances are also assessed periodically.

Recommendations. In order to strengthen existing management plans, programs that will enhance our understanding of the population structure, seasonal habitat requirements, and foraging habitat are needed.

ACKNOWLEDGMENTS.— The Nongame Section of the North Carolina Wildlife Resources Commission provided funding to the N.C. State Museum for the study of the distribution and habitat requirements of this bat. Bob Currie of the USFWS and personnel with the Tennessee Valley Authority also provided information.

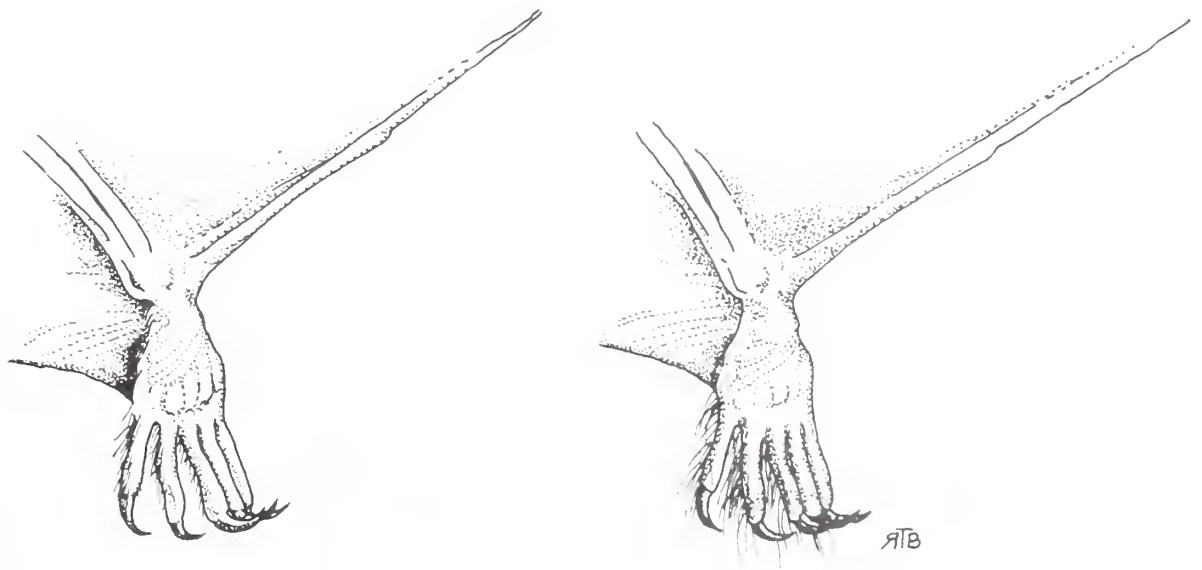
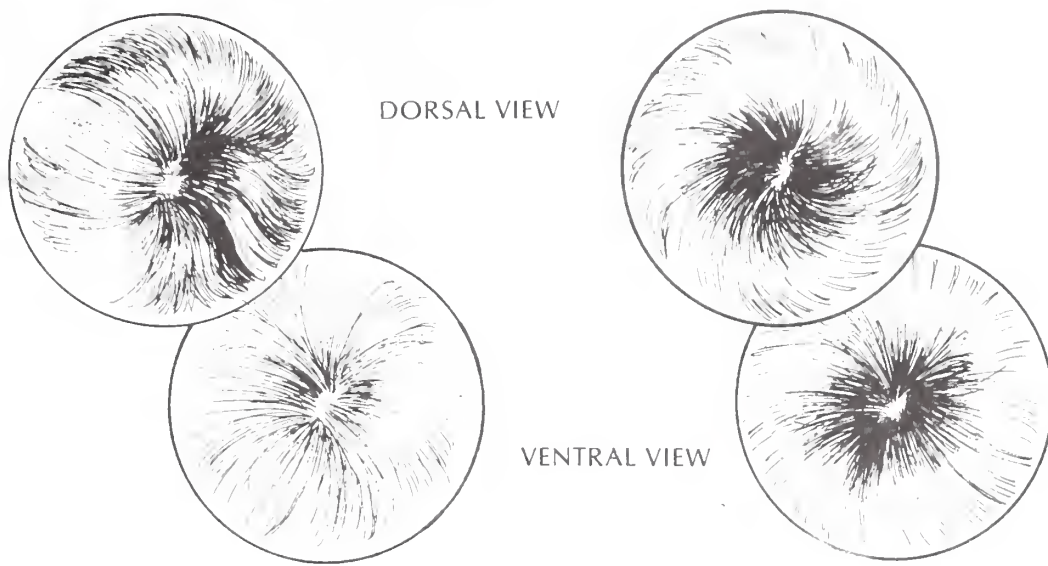


Fig. 4. The parted fur of *Plecotus townsendii* (left) is uniform in color both dorsally and ventrally. *Plecotus rafinesquii* (right) has bicolored fur with a sharp contrast between the light tips and dark bases. Hairs do not extend beyond the toes in *townsendii* but do so in *rafinesquii*.

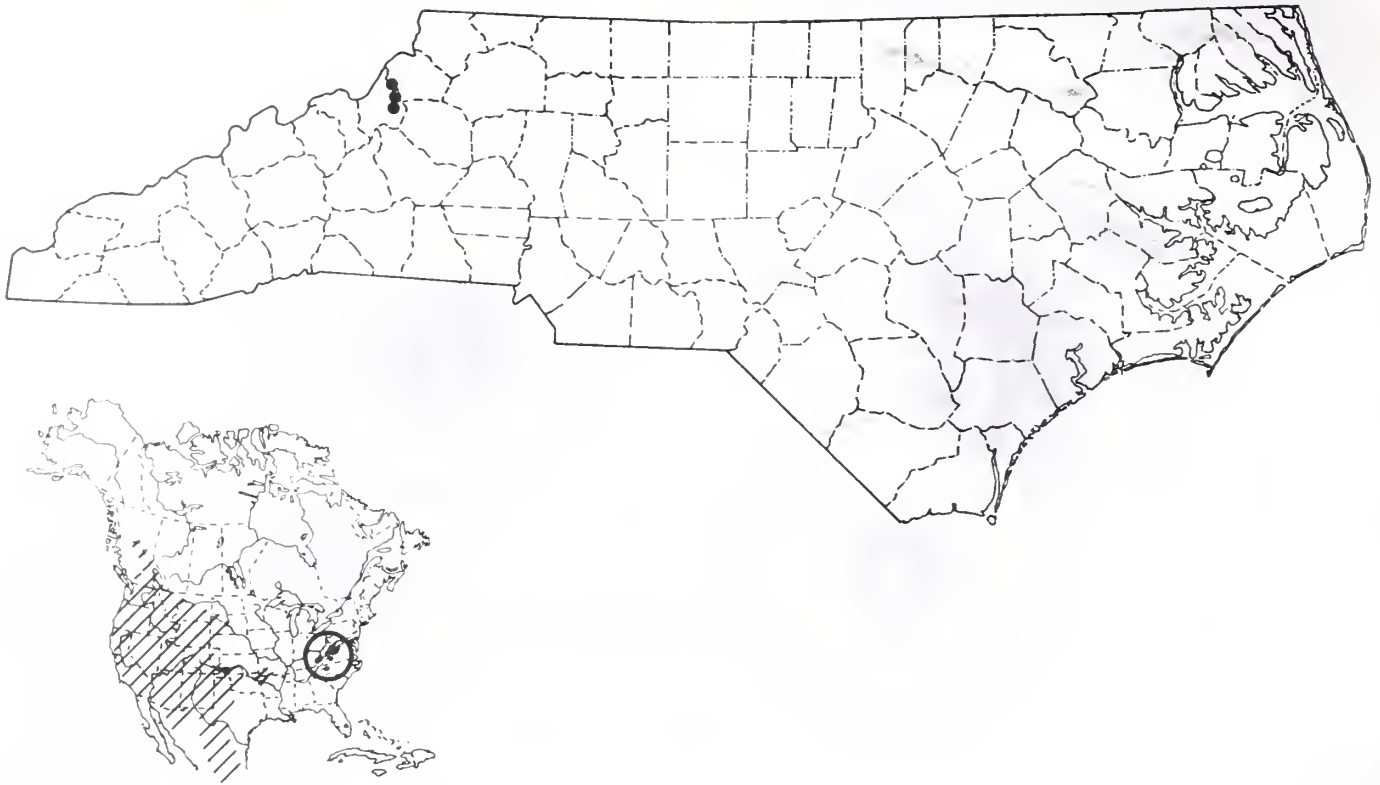


Fig. 5. Distribution of the Virginia Big-eared Bat, *Plecotus townsendii virginianus*, in North Carolina and eastern North America (circled area on insert). Hatching indicates the distribution of the species west of the Mississippi River.

LITERATURE CITED

- Bagley, F. M. 1984. A recovery plan for the Ozark Big-eared Bat and the Virginia Big-eared Bat. U.S. Fish and Wildlife Service.
- Barbour, R. W., and W. H. Davis. 1969. Bats of America. Univ. Press Kentucky, Lexington.
- Clark, M. K., and D. S. Lee. 1987. *Plecotus townsendii* in western North Carolina. *Brimleyana* 13:137-140.
- Handley, C. O. 1959. A revision of the American bats of the genera *Euderma* and *Plecotus*. *Proc. U.S. Natl. Mus.* 110:95-246.
- Howell, A. B. 1920. Some California experiences with bat roosts. *J. Mammal.* 1:169-177.
- Humphrey, S. R., and T. H. Kunz. 1976. Ecology of a Pleistocene relict, the Western Big-eared Bat (*Plecotus townsendii*), in the southern Great Plains. *J. Mammal.* 57:470-494.
- Kunz, T. H., and R. A. Martin. 1982. *Plecotus townsendii*. *Mammal. Species* 175:1-6.

Prepared by MARY KAY CLARK

Glaucomys sabrinus coloratus (Handley) NORTHERN FLYING SQUIRREL

Description. This is a medium-sized squirrel, some 26 to 30.5 cm in total length and 95 to 140 g in weight. It has a broad, flattened tail and dense, silky fur. The

distinctive petagia, folds of skin between front and hind limbs that enable "flying" squirrels to glide, are fully haired from wrist to ankle. Adults are gray with a brownish, tan, or reddish wash dorsally, and grayish white or buffy white ventrally. Juveniles have uniform dark, slate-gray backs and off-white undersides. The Northern Flying Squirrel can be distinguished from the Southern Flying Squirrel, *G. volans*, by its larger size (ex. hindfoot 33-41 mm), the gray base of its ventral hairs as opposed to the white base in the Southern form (Fig. 6), the relatively longer upper tooth row, and the short, stout baculum (penis bone) of the males. For a thorough description of the subspecies see Handley (1953), and see Howell (1918) for a generic revision. Wells-Gosling (1985) provides numerous photographs of both *Glaucomys* species.

Range. The Northern Flying Squirrel occupies boreal coniferous and mixed forests of the northern United States and Canada, the mountain ranges of the West, and certain highland areas of the southern Appalachians (Fig. 7). In the southern Appalachians the subspecies *coloratus* is known from three isolated localities in the mountains of North Carolina and Tennessee: Roan Mountain, Mount Mitchell, and the Great Smoky Mountains (Handley 1980). The pre-settlement distribution of the species in the Southeast is unknown, but fossil remains indicate a much larger

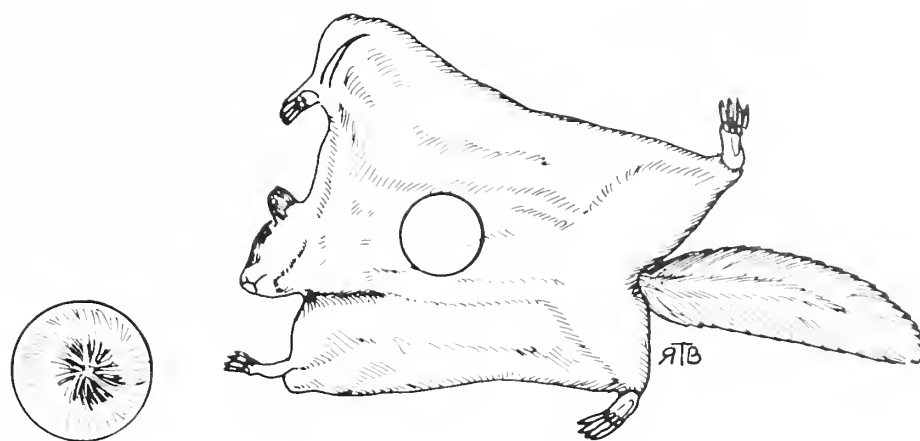


Fig. 6. The Northern Flying Squirrel, *Glaucomys sabrinus*, is most easily distinguished from the Southern, *G. volans*, by its large size, broad and more heavily furred tail, and the gray bases of its ventral hairs.

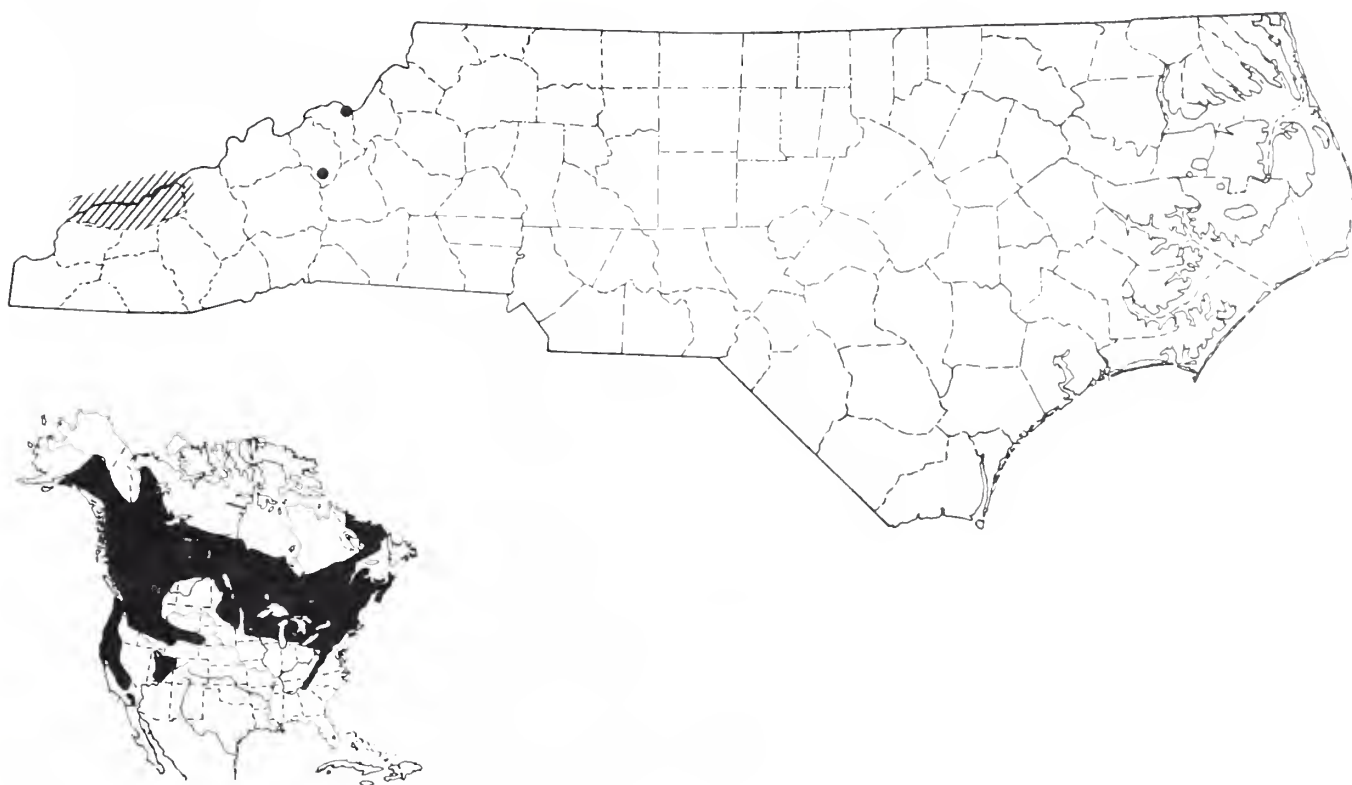


Fig. 7. The known distribution of *Glaucomys sabrinus* in North Carolina. Hatching indicates the Great Smoky Mountains National Park. Total range of the species is shown on the insert of North America.

range during the late Pleistocene and Holocene than at the present time (Kurten and Anderson 1980, Lundelius et al. 1983, Semken 1983).

Habitat. Although often associated with spruce-fir forests, this form is more commonly captured in adjacent stands of mature hardwoods (beech, Yellow Birch, maple, hemlock, Northern Red Oak, and buckeye) at altitudes above 1500 m (5000 feet). One specimen has been taken at an elevation of 1200 m (4000 feet) in the Great Smoky Mountains. Mature, open forest seems well suited to the species' gliding form of locomotion. The abundance of natural cavities in old hardwoods and their relative resistance to wind-throw (compared to many conifers) may account for the flying squirrel's occupation of the deciduous and mixed woodland just below the spruce-fir zone.

Life History and Ecology. Because of its rarity, nocturnal and secretive habits, and the remoteness of its habitat, little is known of the ecology of the southernmost subspecies of the Northern Flying Squirrel. Compared to *G. volans*, it is less dependent on seeds and nuts for food (Weigl 1978) and, in fact, may not be able to use conifer seeds effectively in some boreal habitats (Brink 1965). Over much of its range it can apparently subsist on lichens and fungi (Weigl 1968, Maser et al. 1985), but also takes certain seeds, buds, fruits, staminate cones, insects, and other animal material (McKeever 1960). The year-round abundance of lichens and many species of hypogeous (underground) fungi may provide a steady and almost exclusive food supply that reduces the frequency and intensity of food competition with other squirrel species. Such requirements may also be a factor in restricting the species to high-elevation, mesic habitats.

Nesting sites are critical resources because of the flying squirrel's small size, the climatic severity of its habitat, and the abundance of avian and mammalian predators. During the cold months, squirrels commonly occupy tree cavities and woodpecker holes (Cowan 1936, Jackson 1961, Baker 1983); but they may also construct and use leaf nests, especially in the summer (Weigl and Osgood 1974). Regardless of type, the interior of the nest is lined with lichens, moss, or finely chewed bark. Little reproductive information is available for this subspecies. Investigators working with northern populations mention two litters of 2 to 6 young per year and a gestation period of 37 to 42 days (Davis 1963, Muul 1969). However, trapping data from the southern Appalachians suggest a single annual litter in early spring. Two captive females each bore four young.

Northern Flying Squirrels are relatively gregarious and are known to share nests; however, the spectacular winter nesting aggregations reported for *G. volans* (up to 50 in a nest) are unknown for this species. Northern Flying Squirrels apparently live in family groups of adults and juveniles, for it has often been possible to trap two to six individuals within an area measuring

300 by 400 m. Such data may also indicate a maximum density of one squirrel per 2 ha. Territorial determinations based on summer telemetry data suggest individual home ranges of 2 to 3 ha (Weigl and Osgood 1974).

Special Significance: The disjunct distribution of this squirrel in North Carolina and its great distance from the center of the species' range in the northern United States and Canada suggest that it is a relict form that has become isolated in small patches of suitable habitat by changing climatic and vegetational conditions since the last ice age.

Status. Federally Endangered (50 FR 27002, 1 July 1985).

Rationale for Evaluation. All presently available information indicates that this species is exceptionally rare and may be experiencing further range contraction in North Carolina. Since Handley named the subspecies in 1953, only seven specimens have been reported from the Mount Mitchell area and one from the Great Smoky Mountains. While animals continue to be captured at Roan Mountain from time to time (12 in the past 17 years), squirrel populations appear to be lower than they were in the 1960s. In addition, only one range extension has been reported in spite of the intensive survey work of Linzey in 1981 and 1982 and the extensive trapping by numerous researchers in the Appalachian highlands. Apparently the squirrel's rarity, secretive nature, and low trapability, as well as the relative remoteness of its habitat, greatly reduce the likelihood of detecting populations at old or new sites. There is also some evidence that the species may undergo wide fluctuations in numbers or range. The other rare subspecies of the Appalachians, *G. sabrinus fuscus*, was initially known from a few areas in Virginia and West Virginia (Miller 1936). Thereafter, in spite of intensive work, no specimens were reported for many years. Then in 1985 a number of flying squirrels were taken at two former capture sites (K. Knight, pers. comm.). Whatever the reasons for the low frequency of *sabrinus* finds, it is clear that the species is among the rarest mammals of North Carolina.

Reduction of the range and numbers of this species in the southern Appalachians can be attributed to a number of cultural and natural factors. Habitat destruction associated with clear cutting, timber management, recreational development, or pollution (heavy metals, insecticides, herbicides) may have taken a toll on the species. Habitat modification may also have favored the spread and proliferation of competitors or pathogens. Recent research indicates that *G. sabrinus* may be displaced by the more aggressive and agile *G. volans* in certain hardwood habitats where their ranges overlap. The latter species has been trapped at two localities in North Carolina adjacent to areas once occupied by the former. There is also some evidence that the Southern Flying Squirrel harbors a parasitic

nematode of the genus *Strongyloides*, which can be transferred to the northern species in the contact zone with debilitating results (Weigl 1975).

Current Protection. In 1985 the U.S. Fish and Wildlife Service classified *Glaucomys sabrinus coloratus* and *G. s. fuscus* as endangered subspecies.

Recommendations. Two courses of action are of particular importance in preserving this species in North Carolina. First, a vast amount of information on its basic biology—habitat requirements, diet, demographic characteristics, and relations with other species—is needed in order to understand the animal well enough to formulate an effective management plan. Apart from taxonomic and distributional research, only one ecological study has ever been conducted on the Southeastern subspecies. Second, until better data are available on this squirrel, it would be prudent to protect all or most major areas of northern hardwood habitat lying adjacent to spruce-fir forests and especially those areas where the subspecies has been collected.

LITERATURE CITED AND SELECTED REFERENCES

- Baker, R. H. 1983. Michigan Mammals. Michigan State Univ. Press, East Lansing.
- Brink, C. H. 1965. Spruce seed as a food of the squirrels *Tamiasciurus hudsonicus* and *Glaucomys sabrinus* in interior Alaska. Unpubl. M.S. thesis, Univ. Alaska, College.
- Cowan, I. M. 1936. Nesting habits of the flying squirrel *Glaucomys sabrinus*. J. Mammal. 17:58-60.
- Davis, W. 1963. Reproductive ecology of the Northern Flying Squirrel. Unpubl. M.A. thesis, Univ. Saskatchewan, Canada.
- Handley, C. O., Jr. 1953. A new flying squirrel from the southern Appalachian Mountains. Proc. Biol. Soc. Wash. 66:191-194.
- . 1980. Northern Flying Squirrel. Pages 513-516 in *Endangered and Threatened Plants and Animals of Virginia*, D. W. Linzey, editor. Va. Polytech. Inst. and State Univ., Blacksburg.
- Howell, A. H. 1918. Revision of American flying squirrels. N. Amer. Fauna 44:1-64.
- Jackson, H. H. T. 1961. Mammals of Wisconsin. Univ. Wisconsin Press, Madison.
- Kurten, B., and E. Anderson. 1980. Pleistocene Mammals of North America. Columbia Univ. Press, New York.
- Lundelius, E. L., Jr., R. W. Graham, E. Anderson, J. Guilday, J. A. Holman, D. Steadman, and S. D. Webb. 1983. Terrestrial vertebrate faunas. Pages 311-353 in *Late-Quaternary Environments of the United States*. Vol. I, The Late Pleistocene, S. C. Porter, Jr., editor. Univ. Minnesota Press, Minneapolis.
- Maser, Z., C. Maser, and J. M. Trappe. 1985. Food habits of the Northern Flying Squirrel (*Glaucomys sabrinus*) in Oregon. Can. J. Zool. 63:1084-1088.
- McKeever, S. 1960. Food of the Northern Flying Squirrel in northeastern California. J. Mammal. 41:270-271.
- Miller, G. S., Jr. 1936. A new flying squirrel from West Virginia. Proc. Biol. Soc. Wash. 49:143-144.
- Muul, I. 1969. Mating behavior, gestation period, and development of *Glaucomys sabrinus*. J. Mammal. 50:121.
- Radvanyi, A. 1959. Inherent rhythms of activity of the Northern Flying Squirrel in relation to illumination and to lunar and solar photoperiodism. Unpubl. Ph.D. dissert., Univ. British Columbia, Canada.
- Semken, H. A., Jr. 1983. Holocene mammalian biogeography and climatic change in the eastern and central United States. Pages 182-207 in *Late-Quaternary Environments of the United States*. Vol. II, The Holocene, H. F. Wright, Jr., editor. Univ. Minnesota Press, Minneapolis.
- Weigl, P. D. 1968. The distribution of the flying squirrels *Glaucomys volans* and *G. sabrinus*: an evaluation of the competitive exclusion idea. Unpubl. Ph.D. dissert., Duke Univ., Durham, N.C.
- . 1975. Parasitism as a possible biological weapon affecting the ranges and interactions of the flying squirrels, *Glaucomys volans* and *G. sabrinus*. (Abstract.) 55th Annual Meeting, Amer. Soc. Mammal., Univ. Montana.
- . 1978. Resource overlap, interspecific interactions and the distribution of the flying squirrels, *Glaucomys volans* and *G. sabrinus*. Amer. Midl. Nat. 100:83-96.
- , and D. W. Osgood. 1974. Study of the Northern Flying Squirrel, *Glaucomys sabrinus* by temperature telemetry. Amer. Midl. Nat. 92(2):482-486.
- Wells-Gosling, N. 1985. Flying Squirrels, Gliders in the Dark. Smithsonian Institution Press, Washington, D.C.
- Wells-Gosling, N., and L. R. Heaney. 1984. *Glaucomys sabrinus*. Mammal. Species 247. Amer. Soc. Mammal.

Prepared by PETER D. WEIGL

Felis concolor True PANTHER

Description. This is a very large, long-tailed cat, attaining total lengths of 1.8 to 2.3 m (6 to 7.5 feet) and weights of 45 to 67.5 kg (100 to 150 pounds). The maximum recorded length is about 2.8 m (9.33 feet), and maximum weight recorded is around 102 kg (225 pounds). The short fur is plain brownish, with whitish underparts, and the tip of the tail is conspicuously dark. The cubs are light brown with irregular, brownish-black spots. Tracks of the adult are quite large (9 cm; 3.5 inches), and the retractable claws do not show. Prints of the front and hind feet often overlap but seldom register. Its route of travel is often direct, whereas bobcats usually travel in an irregular or circling path. There are no specimens from North Carolina in collections, thus it is not possible to assign subspecific status to North Carolina populations. It is likely that both *F. c. cougar* Kerr and *F. c. coryi* Bangs, with intergrades, once occurred in North Carolina. Illustrations of the adult and tracks are in Figure 8.

Distribution. The range is currently disjunct in wilderness areas of the United States (Fig. 9). This species is still common in some western states. Currently

it is regarded as occurring in parts of Florida and from Arkansas and Louisiana west to the Pacific Coast. Several recent records are available from eastern Canada, and numerous unsubstantiated sight records make the current hiatus in the range difficult to delineate. This cat also ranges through Mexico and South America. It once had the largest range of any native American land mammal, occurring throughout most of the western hemisphere from British Columbia to Patagonia, and from sea level to elevations of 3,300 m (nearly 11,000 feet).

The current status in North Carolina is unclear, but the Panther is assumed to have been extirpated from the state. The species is included in this report, however, because reports of its presence persist, which is not the case with other large extirpated mammals. Its occurrence is postulated on the basis of recent sight records, most from remote sections of the state's Coastal Plain and the Appalachian Mountains (see Lee 1977). The Panther possibly occurs in some relatively uninhabited areas where deer are numerous. Since the late 1960s, various persons and agencies have made repeated attempts to document the presence of this cat in the state. Despite considerable effort, no convincing evidence yet exists.

Habitat. This graceful carnivore is largely a creature of remote, rugged habitats: mountains, gorges, and swamps.

Life History and Ecology. The Panther may be active at any hour, but it seems to be chiefly nocturnal. Hornocker (1969) found that females had a home range of 5 to 20 square miles, while the territories of males covered 25 square miles or more. Deer is regarded as the preferred food. The cats may cover large carcasses with debris and return later for additional feedings. They take domestic stock infrequently, although individual Panthers occasionally become problems. They normally shun all contact with humans, and verified attacks are extremely rare.

Females become sexually mature at 2 to 3 years of age, breeding at 2- to 3-year intervals. Males may not become mature until the fourth or fifth year. After a gestation period of 90 days, from one to four, usually two, young are born. The young lose their spotted coat in about 6 months but remain with the female for up to 2 years (Wright 1972). Ten to twelve years seems to be the normal life span of captive individuals.

Status. *Felis concolor cougar*, Federally Endangered (38 FR 14678, 4 June 1975).

Rationale for Evaluation. This big cat is accorded endangered status in the federal and the International Union for Conservation of Nature and Natural Resources (IUCN) lists. For many years it was believed extirpated from much of eastern North America.

For the last several decades considerable debate about the possible survival of the Panther in the central Atlantic states has persisted, and local reports of

occurrence continue. Although it is unlikely that Panthers still roam our forests, it does not seem wise to discredit some recent records. Even though much of the evidence is circumstantial, reports indicate that this cat may still occur in Pennsylvania (Doutt 1969), Virginia (Russ 1975), Tennessee (Horan 1976), North Carolina (Lee 1977), Maryland (Lee 1984), South Carolina (Sass 1954), and in provinces of southern Canada (Downing 1981). Wright (1972) stated that the total number of Panthers surviving in eastern North America, exclusive of Florida, may not be more than a hundred, and may be far fewer.

In North Carolina there have always been a modest number of Panther reports each year. Sightings seem to be increasing, both in location and in number (Lee 1977). The late Fred Barkalow, Zoology Department, N.C. State University (pers. comm.), obtained the first evidence for the recent occurrence of this species in the state. Hair from a tree in Gaston County was tentatively identified as Panther fur; but this identification was never verified, and the sample has since been lost. In spite of considerable effort, no substantial new information has become available on this cat since the publication of the proceedings of the 1975 Symposium on Endangered and Threatened Biota of North Carolina (Cooper et al. 1977). Clark et al. (1985) provide some historical information for pocosin areas in the eastern portion of the state and also present some insight into the source of reports of "Black Panthers."

The Panther's only enemy is man, whose deliberate persecution and alteration of habitat drove the Eastern populations to the brink of extinction years ago. Because this cat is a top-order carnivore, fecundity is low, and recovery will be slow even if local populations can be found and adequate protection can be assured. In many ways certain areas of North Carolina are wilder and more remote now than they were at the turn of the century. Vast sections are designated as National Forests, and extensive timber management areas exist. Even though the human population of the state has greatly increased, it has not had much direct impact on really wild areas. The successful restocking and spectacular comeback of the White-tailed Deer strengthen the belief that portions of North Carolina could again support viable Panther populations.

Remarks. In early 1987, after a rash of sight reports, two adults of this species were shot in Tyrrell County. Although information on these cats is still being processed, one, an adult male, shot while it foraged in a trash container, had a tattoo (Warren Parker, USFWS, pers. comm.) This animal and a starving Panther kitten that wandered into someone's home in western North Carolina in 1986 (Allen Boynton, NCWRC, pers. comm.) suggest that at least some captive animals are being released in the state. While it is not possible to determine what percentage of sightings are of released captives, it is likely that all recent records should be regarded as suspect until analysis of

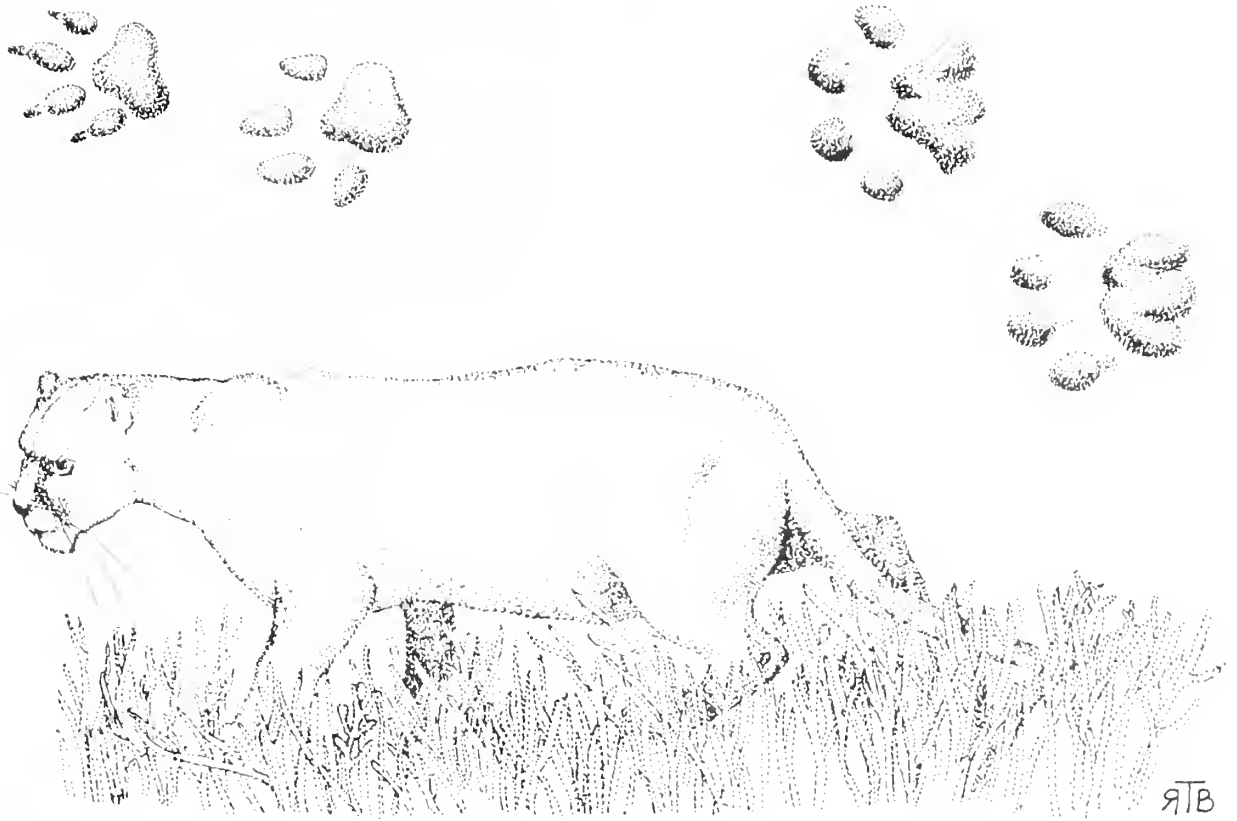


Fig. 8. Although the long tail and large size of the Panther (*Felis concolor*) easily distinguish it from the Bobcat (*Lynx rufus*), these features may not always be obvious under field conditions. The track of the Panther (upper right) is rounded, and claw marks are absent. Tracks of large dogs (upper left) are similar in size to panther tracks but more triangular in shape; claw marks may or may not be present.

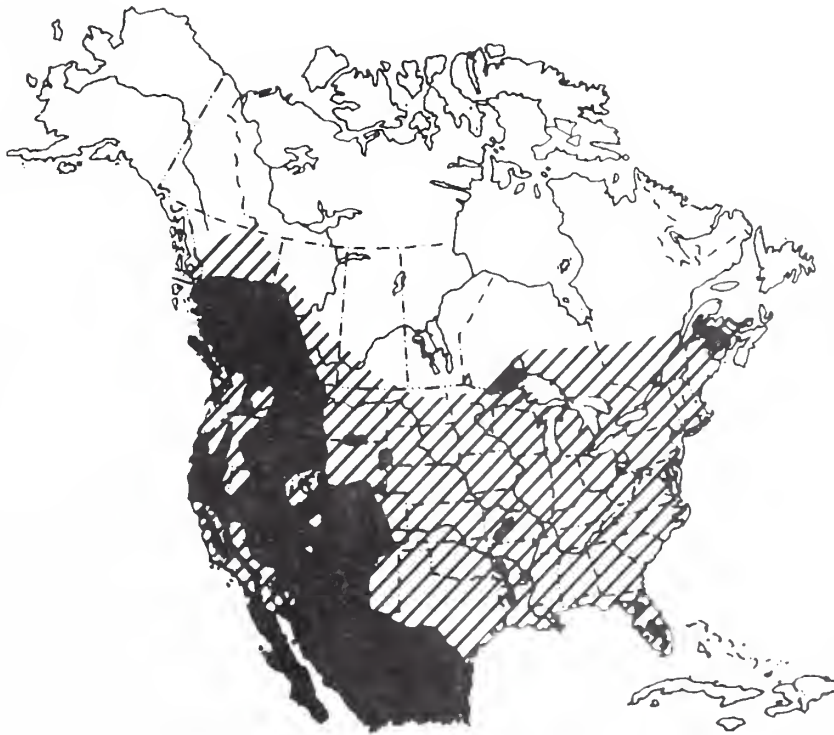


Fig. 9. The current (solid) and historic (hatched and solid) ranges of *Felis concolor* in North America.

the skull and other characters confirm it to be one of the two Eastern subspecies.

In the Southeast the only common name used for this cat was Panther (or sometimes Painter). In other parts of the country several other names are used (Puma, Cougar, Mountain Lion, and Catamount). There are at least 37 sites in the state with the place name of "Panther," including 6 "Panther" branches and 10 "Panther" creeks (Powell 1968). Those in the eastern portion of the state were listed by Clark et al. (1985). These are assumed to represent localities of historical occurrence. Bone fragments of *F. concolor* from Indian middens and bounty records of the 1700s confirm the historic presence of the species in North Carolina.

LITERATURE CITED

- Clark, M. K., D. S. Lee, and J. B. Funderburg. 1985. The mammal fauna of Carolina bays, pocosins, and associated communities in North Carolina: an overview. *Brimleyana* 11:1-38.
- Cooper, J. L., S. S. Robinson, and J. B. Funderburg (editors). 1977. *Endangered and Threatened Plants and Animals of North Carolina*. N.C. State Mus. Nat. Hist., Raleigh.
- Doutt, J. K. 1969. Mountain lions in Pennsylvania? *Amer. Midl. Nat.* 82:281-285.
- Downing, R. L. 1981. Eastern Cougar Recovery Plan. U.S. Fish and Wildlife Service.
- Horan, J. 1976. Rare cougars may yet stalk the Carolinas (with photo of specimens shot in Tennessee in 1971). *The Charlotte Observer*, 18 January 1976.
- Hornocker, M. G. 1969. Winter territoriality in mountain lions. *J. Wildl. Manage.* 33:457-464.
- Lee, D. S. 1977. Unscrambling rumors: the status of the Panther in North Carolina. *Wildlife in N.C.* 41:6-9.
- Lee, D. S. 1984. Maryland's vanished birds and mammals: reflections of ethics past. Pages 454-471 in *Threatened and Endangered Plants and Animals of Maryland*. A. W. Norden et al., editors. Md. Dept. Nat. Resources.
- Powell, W. S. 1968. *The North Carolina Gazetter*. Univ. North Carolina Press, Chapel Hill.
- Russ, W. P. 1975. The rare and endangered terrestrial vertebrates of Virginia. M.S. thesis, Va. Polytech. Inst. and State Univ., Blacksburg.
- Sass, H. R. 1954. The Panther prowls the East again. *The Saturday Evening Post*, 13 March 1954, 32:133-134.
- Wright, B. S. 1972. *The Eastern Panther: A Question of Survival*. Clarke, Irwin, and Co., Ltd., Toronto, Canada.

Prepared by DAVID S. LEE

Trichechus manatus Linnaeus

WEST INDIAN (FLORIDA) MANATEE

Description. The manatee (Fig. 10) is a massive, barrel-shaped aquatic mammal averaging from 3 to 4 m (approximately 10 to 13 feet) in length and normally weighing less than 500 kg (about 1100 pounds). The maximum recorded length is 4.6 m (15 feet), and the

maximum weight recorded is 680 kg (1,500 pounds) (Hall 1981: Vol. II, p. 1073).

The tough, thick skin is uniformly gray to gray-brown, wrinkled, and nearly hairless. The neck is short, merging with the body, and the head is rounded with a squared-off muzzle. Both the eyes and external ears are minute in relation to body size. The upper lip has stiff tactile hairs and is cleft, lobed, and fleshy. Forelimbs are short and paddlelike; hind limbs are lacking. The tail is horizontally flattened and rounded.

Manatees are difficult to observe in North Carolina's turbid rivers. They generally swim from 1 to 3 m below the surface of the water, lifting only the nostrils out of the water every few minutes (Fig. 10).

Range. The West Indian Manatee is known from shallow waters throughout most of the tropical and subtropical regions of the New World Atlantic coast (Fig. 11). In North America it ranges from coastal North Carolina to the Florida Keys and the Gulf of Mexico, and west to the Louisiana coast. Once found more extensively along the Texas and Louisiana coasts, it is now only occasionally observed in the extreme southern part of coastal Texas. Records exist from Delaware, New Jersey, and Virginia. The manatee is also found along the Atlantic coasts of Central and South America south to Brazil, and throughout the Caribbean Islands to an unknown degree (it is still extant in Puerto Rico). (Distributional information was summarized from USFWS 1980.)

Peninsular Florida has always been the center of the range within the continental United States. Records as far north as the Carolinas and Virginia (Brimley 1931, McAtee 1950, Moore 1951a) are generally considered exceptional. Browne and Lee (1977) investigated the summer distribution of the manatee in this state during 1975 and 1976 in a cooperative program with the U.S. Fish and Wildlife Service. Results of this investigation indicated that manatees occur in North Carolina waters from June to early October. A dead manatee (NCSM 5252) found on a dredge island in the mouth of the Cape Fear River in March 1986 is the most recent confirmed record and seems to represent an atypical occurrence. This late-winter specimen suggests that some manatees may overwinter in warm-water discharges from coastal North Carolina power plants.

Although the migratory North Carolina population is undoubtedly small, regular reports of this animal from our coastal rivers suggest that the occurrence of the manatee in North Carolina should not be considered exceptional. Campbell (1977) noted that the paucity of data on this animal in North Carolina "results more from lack of attention than from lack of Manatees."

Habitat. Limited to waters above 21 °C, manatees frequent shallow, nearshore marine and estuarine habitats and move up sluggish rivers for variable distances. Factors that influence habitat choice are (1) the availability of food, (2) proximity to channels at

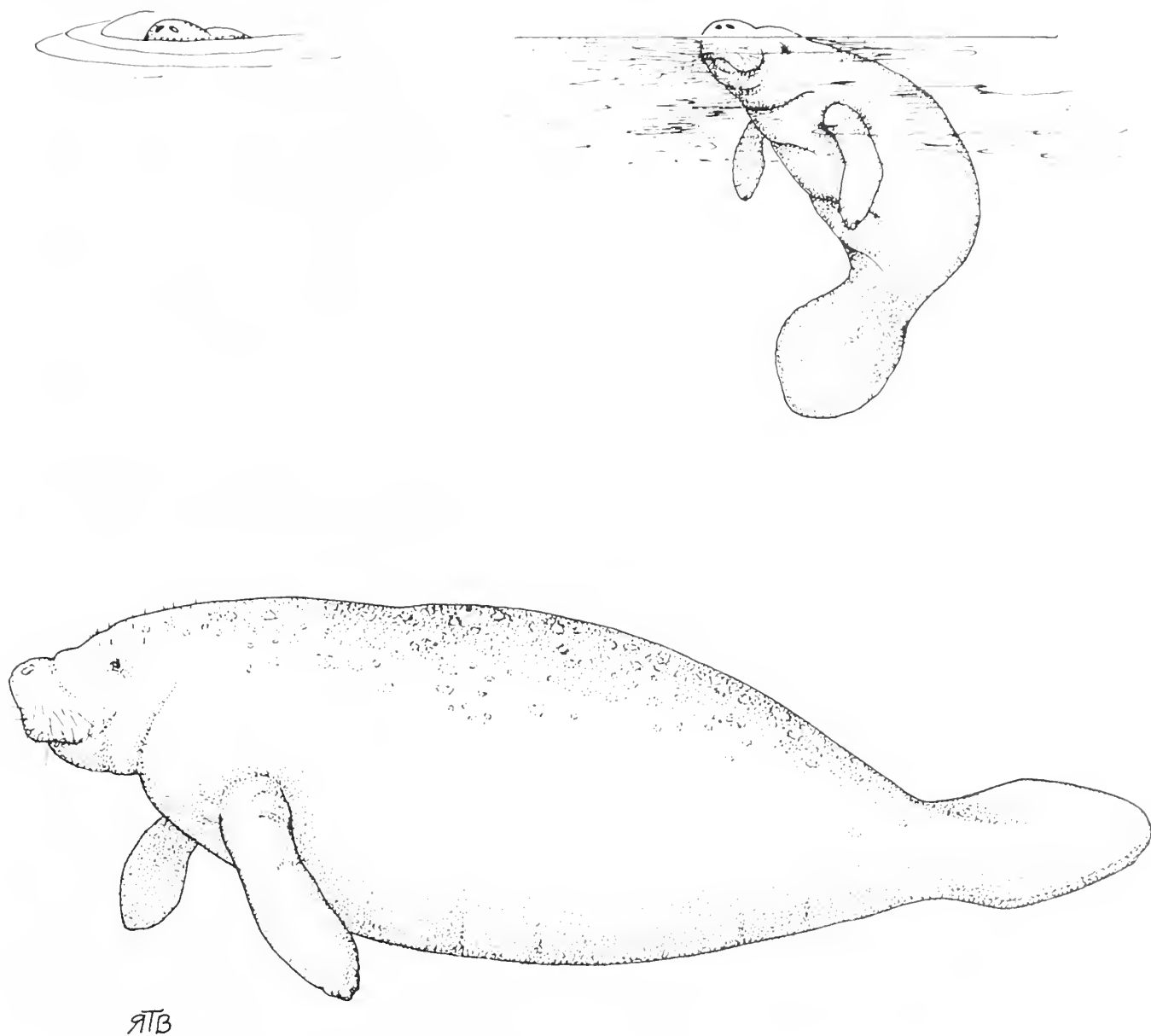


Fig. 10. The whole body of the West Indian (Florida) Manatee may be visible in clear water; but in the dark and muddy waters of coastal North Carolina, one normally sees only a small part of the head when the manatee raises its nose to breathe (upper left).



Fig. 11. Locations of specimens of manatees, *Trichechus manatus*, known from North Carolina. The center of the manatee's distribution in the continental United States has always been peninsular Florida, but the species ranges into other areas on a less regular basis.

least 2 m deep, (3) access to warm water during cold winter weather, and (4) a source of fresh water, which is apparently required for osmoregulation (Hartman 1979).

Life History and Ecology. The West Indian Manatee is a slow-moving (from 3 to 7 km/hr) herbivore of potential importance in energy and nutrient cycling. In captivity this species reportedly eats 30 to 50 kg of food daily (Hartman 1968, in Husar 1978). The diet consists primarily of submerged vascular plants, but emergent and floating vegetation is sometimes taken. Dietary habits are described in detail by Hartman (1979). O'Shea (1986) recently reported manatees feeding regularly on mast in Blue Spring, Fla.

Manatees are migratory, responding to changes in temperature, and seem to follow established routes. In Florida, manatees migrate south, to warm-water springs or man-made thermal refugia when the temperature reaches 10 to 15 °C (Moore 1951a). Several authors have presented evidence of north and south migrations in the United States (Hartman 1979, Moore 1956, Hamilton 1941).

Hartman (1979) made hundreds of hours of observations under natural conditions of the behavior of the manatee in Florida. He found that they are essentially solitary animals, but groups of two to six

have been reported (Layne 1965, Charnock-Wilson 1968, and Moore 1951b). The family is the strongest social unit and consists of a cow with its calf. All other associations are loosely organized.

There appears to be no definite breeding season in Florida. Estroous females are accompanied by an entourage of courting bulls for a week to a month. Gestation lasts approximately 13 months. Fecundity is low with only one calf produced at 2- to 3-year intervals. Pinkish at birth, calves are about 1 m long and weigh from 18 to 27 kg. Young may remain with mothers for several years. Males reach sexual maturity at 9 to 10 years of age, females at 8 to 9 years. Longevity in the wild is unknown, but a captive at the South Florida Museum was known to be 23 years old in 1973 (Husar 1978).

Status. Federally Endangered (32 FR 4001, 11 March 1967; 35 FR 8495, 2 June 1970.)

Rationale for Evaluation. Although no accurate quantitative census is available, populations are presumed to be low. An estimate based on an aerial survey of winter congregations in Florida suggests a minimum total United States population of perhaps 1,000 individuals. Reports from the 1800s and early 1900s indicate a much larger population, perhaps many thousands (USFWS 1980).

Causes of Decline. Currently, human activities are by far the greatest cause of manatee mortality in the United States. Heavy exploitation for meat appears to have been responsible for the initial decline. This practice still continues outside the United States. Much manatee habitat has been lost, but the major mortality factor today appears to be injury from boat and barge collisions and drowning caused by accidental entrapment in floodgates or canal locks. Poaching and vandalism also contribute significantly to mortality (summarized from USFWS 1980).

Manatees are apparently highly susceptible to pneumonia and other bronchial disorders (Husar 1978). The availability of artificial refugia, such as waters discharged from power plants, may cause manatees to winter in areas not naturally suited to their needs (Campbell et al. 1978 in USFWS 1980). Partial shutdown in combination with severe winters may cause animals to die from conditions caused by sudden exposure to cold air and water temperatures.

Oil spills, herbicides, and other chemical contaminants are possible causes of mortality, but further investigation is needed. Accidental or purposeful harassment by swimmers, divers, and curious boaters may cause disruption of important social functions.

Current Protection. The manatee has been protected by Florida State Law since 1893. Federal efforts toward protection began in 1967, when the manatee was listed as an endangered species under the Endangered Species Preservation Act of 1966. The Endangered Species Act of 1973 superseded the 1966 act and subsequent acts, and provided increased federal protection. Among other limitations, the Endangered Species Act of 1973 makes it illegal to "harass, harm, pursue, hunt, shoot, wound, kill, trap, or collect" manatees. The manatee is also protected under the Marine Mammal Protection Act of 1972.

Remarks. Because exploitation continues in many parts of the range outside the United States, every effort must be made to prevent extinction within this country. The potential for captive propagation is believed to be low because of low fecundity. Space and food requirements make long-term captive maintenance expensive.

While this species now appears to be only an occasional seasonal visitor to North Carolina waters, there is no justification for discounting the importance of local habitats to the species. These will be especially important if protective measures in other areas result in population increases. The N.C. State Museum regularly receives reports of manatees in the state, and there is reason to suspect that the present paucity of data on this animal in North Carolina results from lack of attention and the special problems associated with the study of marine mammals.

Research on distribution within the state is critical. Areas of significant manatee usage should be deter-

mined, seasonal presence documented, and migration routes delineated. An education campaign is needed to encourage sight reports from the public.

LITERATURE CITED AND SELECTED REFERENCES

- Allen, G. M. 1942. Extinct and Vanishing Mammals of the Western Hemisphere. Amer. Com. for International Wild Life Protection, Washington, D.C.
- Brimley, H. H. 1931. The manatee in North Carolina. J. Mammal. 12:320-321.
- Browne, M. M., and D. S. Lee. 1977. The manatee in North Carolina. (Abstract.) ASB Bull. 24(2):40.
- Caldwell, D. K., and F. B. Golley. 1965. Marine mammals from the coast of Georgia to Cape Hatteras. J. Elisha Mitchell Sci. Soc. 81:24-32.
- Campbell, H. W. 1977. *Trichechus manatus* Linnaeus. Florida (West Indian) Manatee. Pages 396-397 in Endangered and Threatened Plants and Animals of North Carolina, J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. N.C. State Mus. Nat. Hist., Raleigh.
- Campbell, H. W., and J. A. Powell. 1976. Endangered species: the manatee. Fla. Naturalist, April 1976:15-20.
- Charnock-Wilson, J. 1968. The manatee in British Honduras. Oryx 9:293-294.
- Hall, E. R. 1981. The Mammals of North America. Vol. II. John Wiley and Sons, New York.
- Hamilton, W. J., Jr. 1941. Notes on some mammals of Lee County, Florida. Amer. Midl. Nat. 25:690.
- Hartman, D. S. 1973. Distribution and status of the manatee, *Trichechus manatus* Linnaeus, in the United States. U.S. Dept. Int., Bur. Sport Fish. and Wildl., Spec. Sci. Rep.
- Hartman, D. S. 1979. Ecology and Behavior of the Manatee, *Trichechus manatus* Linnaeus, in Florida. Amer. Soc. Mammal. Spec. Publ. No. 5.
- Husar, S. L. 1978. *Trichechus manatus*. Mammal. Species 93:1-5.
- Irvine, A. B., D. K. Odell, and H. W. Campbell. 1978. Manatee mortality in the southeast United States from 1974 to 1977. Unpubl. paper presented at the West Indian Manatee Workshop, Orlando, Fla., 27-29 March 1978.
- Layne, J. N. 1965. Observations on marine mammals in Florida waters. Bull. Florida State Mus., Biol. Sci. 9:131-181.
- Lowery, G. H., Jr. 1974. The Mammals of Louisiana and its Adjacent Waters. La. State Univ. Press, Baton Rouge.
- McAtee, W. L. 1950. Possible early record of a manatee in Virginia. J. Mammal. 31:98-99.
- Moore, J. C. 1951a. The range of the Florida Manatee. Quart. J. Fla. Acad. Sci. 14:1-9.
- Moore, J. C. 1951b. The status of the manatee in the Everglades National Park, with notes on its natural history. J. Mammal. 32:22-36.
- Moore, J. C. 1956. Observations of manatees in aggregations. Amer. Mus. Novit. 1811:1-24.
- O'Shea, T. J. 1986. Mast foraging by West Indian Manatees (*Trichechus manatus*). J. Mammal. 67(1):183-185.
- U.S. Fish and Wildlife Service. 1980. West Indian Manatee Recovery Plan.

Prepared by MARY K. CLARK

FEDERALLY THREATENED

Sorex longirostris fisheri Merriam

DISMAL SWAMP SOUTHEASTERN SHREW

Description. The Dismal Swamp Southeastern Shrew, like other long-tailed shrews (genus *Sorex*), has a long pointed nose, tiny eyes, small pinnae that are nearly concealed by the soft brownish pelage, and a tail that is more than half the head and body length. Its dental formula is $3\ 1, 1\ 1/1, 3\ 1, 3\ 3/3 = 32$. This Dismal Swamp endemic is one of the smallest mammals in the state; only the nominate race, which is found elsewhere in the state below 760 m in elevation, and the Pygmy Shrew (*Sorex hoyi*) are smaller (Fig. 20). *Sorex longirostris fisheri* might also be confused with the Masked Shrew (*S. cinereus*), but the latter is found only above 650 m in the western part of the state (as is *S. hoyi*). Dental characteristics also distinguish these species. In *S. longirostris* (as compared to *S. cinereus* from North Carolina) the third upper unicuspid is slightly smaller than or subequal to the fourth (rather than averaging slightly larger), the incisors are relatively smaller, and the teeth are wider, more crowded in the toothrow, and have less pigment. In *S. longirostris* four upper unicuspid are visible when viewed in lateral aspect, whereas in *S. hoyi* only three are obvious because the third upper unicuspid is greatly reduced in size. Also, the first and second upper unicuspid lack distinct secondary cusps on their posterior borders in *S. longirostris*; these are present in *S. hoyi*. Compared to the nominate race, *S. longirostris fisheri* is larger in external and cranial dimensions (but relatively narrower in measurements of cranial breadth) and duller in coloration (brownish above and slightly paler below rather than reddish brown above and grayish below). *Sorex l. eionis*, known only from Citrus County, Fla., is intermediate in size but similar to *S. l. longirostris* in color (Davis 1957). Selected external measurements (in mm), with means in parentheses, of six *S. l. fisheri* are: total length, 92 to 102 (97.7); length of tail, 34 to 40 (37.7); and length of hind foot, 11.5 to 13.0 (12.1) (Jackson 1928).

Range. This race is restricted to the Dismal Swamp region of southeastern Virginia (cities of Suffolk and Chesapeake) and northeastern North Carolina (Camden, Chowan, Currituck, Gates, Pasquotank, and Perquimans counties) (Fig. 12).

Habitat. The Dismal Swamp Southeastern Shrew is most abundant in mesic, 10- to 15-year-old, mid-successional forested areas with grassy or shrubby understories; it is relatively common in recent clearcuts and stands of Cane (*Arundinaria gigantea*) and Softstem Rush (*Juncus effusus*) but relatively uncommon in mature pine and hardwood forests (Rose 1983).

Life History and Ecology. Virtually nothing is known about the natural history of this shrew. Like most other North American shrews, however, the Dismal

Swamp Southeastern Shrew probably tunnels under leaf litter and duff as it rummages for various terrestrial and subterranean arthropods, snails, slugs, worms, caterpillars, and vegetation. Nests of dried leaves and grasses are probably built on relatively high ground in fallen logs and rotting stumps or under rocks. A litter of five young was found in May (Hollister 1911). Molt occurs in spring (late March to early June) and autumn (October); old hair is first replaced on the back and then the sides, venter, and rump (Jackson 1928).

Status. Federally Threatened. (51 FR 34425, 26 September 1986).

Rational for Evaluation. The U.S. Fish and Wildlife Service has listed *Sorex longirostris fisheri* as Threatened because it is confined to the Dismal Swamp, an area that has undergone substantial environmental changes in the last 250 or so years as a result of human activities. Ditching and draining caused a subsequent drop in the water table as upland areas were logged and clear-cut for agricultural purposes. The historic assortment of Bald Cypress (*Taxodium distichum*) and Atlantic White Cedar (*Chamaecyparis thyoides*) swamps, herbaceous marshes and bogs, mesic canebrakes, and upland grasslands and forests has given way to a less diversified mixture of well-drained agricultural plots separated by strips of secondary forests and thickets, lowland creeks and seeps, and undrained swamps. Remaining undisturbed sections of the swamp have been protected since the inception of the Great Dismal Swamp National Wildlife Refuge (GDSNWF) in 1973, and as a result, early seral stages are becoming less common in this sequestered area. Handley (1980) opined that the nominate race, which inhabits the surrounding upland areas, might invade the swamp and cause the genetic extinction of *S. l. fisheri* through introgression with *S. l. longirostris*. Specimens of *S. l. fisheri* from the perimeter of the swamp region are indeed intermediate in size as might be expected, but those from the interior are 15 to 25% larger than typical specimens of *S. l. longirostris* (Rose 1983).

Current Protection. The Dismal Swamp Southeastern Shrew currently is listed as Federally Threatened in Virginia and North Carolina. It is also protected in the GDSNWR and by state and local laws elsewhere in its geographic distribution. *Sorex longirostris fisheri* is now provided protection through the Endangered Species Act of 1973. Further, a management plan is being developed for the GDSNWR, including provisos designed to restore maximum environmental diversity in the region by increasing the height of the water table and selectively maintaining a mosaic of early to late successional stages.

LITERATURE CITED

- Davis, J. A., Jr. 1957. A new shrew (*Sorex*) from Florida. Amer. Mus. Novitates 1844:1-9.

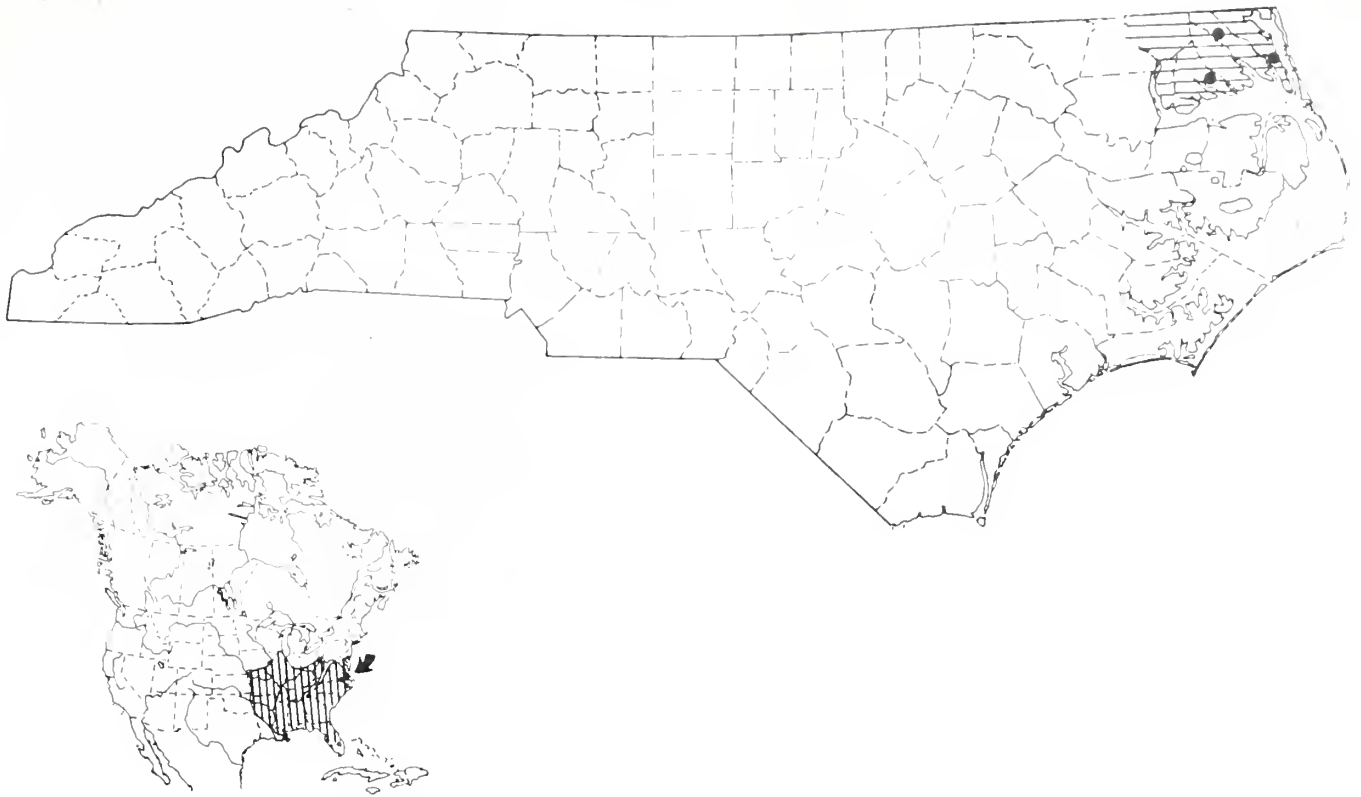


Fig. 12. *Sorex longirostris* is widely distributed in the state and in the southeastern United States, but *S. l. fisheri* is confined to the Dismal Swamp region of North Carolina and Virginia. Dots represent previously recorded specimens, and shaded areas indicate the presumed range.

- Handley, C. O., Jr. 1980. *Sorex longirostris fisheri*. Pages 535-536 in *Endangered and Threatened Plants and Animals of Virginia*, D. W. Linzey, editor. Center for Environmental Studies, Va. Polytech. Inst. and State Univ., Blacksburg.
- Hollister, N. 1911. Remarks on the long-tailed shrews of the eastern United States, with description of a new species. *Proc. U.S. Natl. Mus.* 40:377-381.
- Jackson, H. H. T. 1928. A taxonomic review of the American long-tailed shrews (genera *Sorex* and *Notiosorex*). *N. Amer. Fauna* 51:1-238.
- Rose, R. K. 1983. A study of two rare mammals endemic to the Virginia North Carolina Dismal Swamp. Final report under U.S. Fish and Wildlife Research Grant No. 14-18-0005-81-033.

Prepared by WM. DAVID WEBSTER

VULNERABLE

Plecotus rafinesquii (Lesson)

RAFINESQUE'S BIG-EARED BAT

Description. This is a medium-sized, long-eared bat with glandular lumps on its muzzle. Several characteristics distinguish it from the very similar Virginia Big-eared Bat (*P. townsendi virginianus*), which also occurs in North Carolina. These differences are

illustrated in Figure 4. The long and shaggy fur is usually grayish-brown dorsally and white ventrally. The bases of both the dorsal and ventral hairs are black, making all hairs sharply bicolored. Unlike *P. townsendi*, *P. rafinesquii* has on the feet hairs that extend beyond the toes. Additionally, the first upper incisor is bicuspid. Average measurements (in mm) for five North Carolina females, with the range in parentheses, are: total length 96 (92-103), tail vertebrae 49.2 (47-54), hind foot 10.4 (8-12), and ear (from notch) 31 (28-32). Jones (1977) reports a weight range for males of 7.9 to 9.5 g and a range of from 7.9 to 13.6 g for females.

Range. This is a species of the southeastern United States. It occurs discontinuously west to Louisiana and Oklahoma, north in the interior to Illinois, Indiana, Ohio, and West Virginia, and north on the Atlantic seaboard into the Dismal Swamp in Virginia (Jones 1977). In North Carolina this species is sporadically distributed in forested sections of the Mountain (*P. r. rafinesquii*) and Coastal Plain (*P. r. macrotis*) regions of the state (Fig. 13). The extent of its distribution in the Coastal Plain is under investigation. Little is known about the distribution in the southern Appalachian Mountains. Preliminary investigations indicate that it is much more restricted in these two regions than previously believed. There are no records from the Piedmont region of the state.

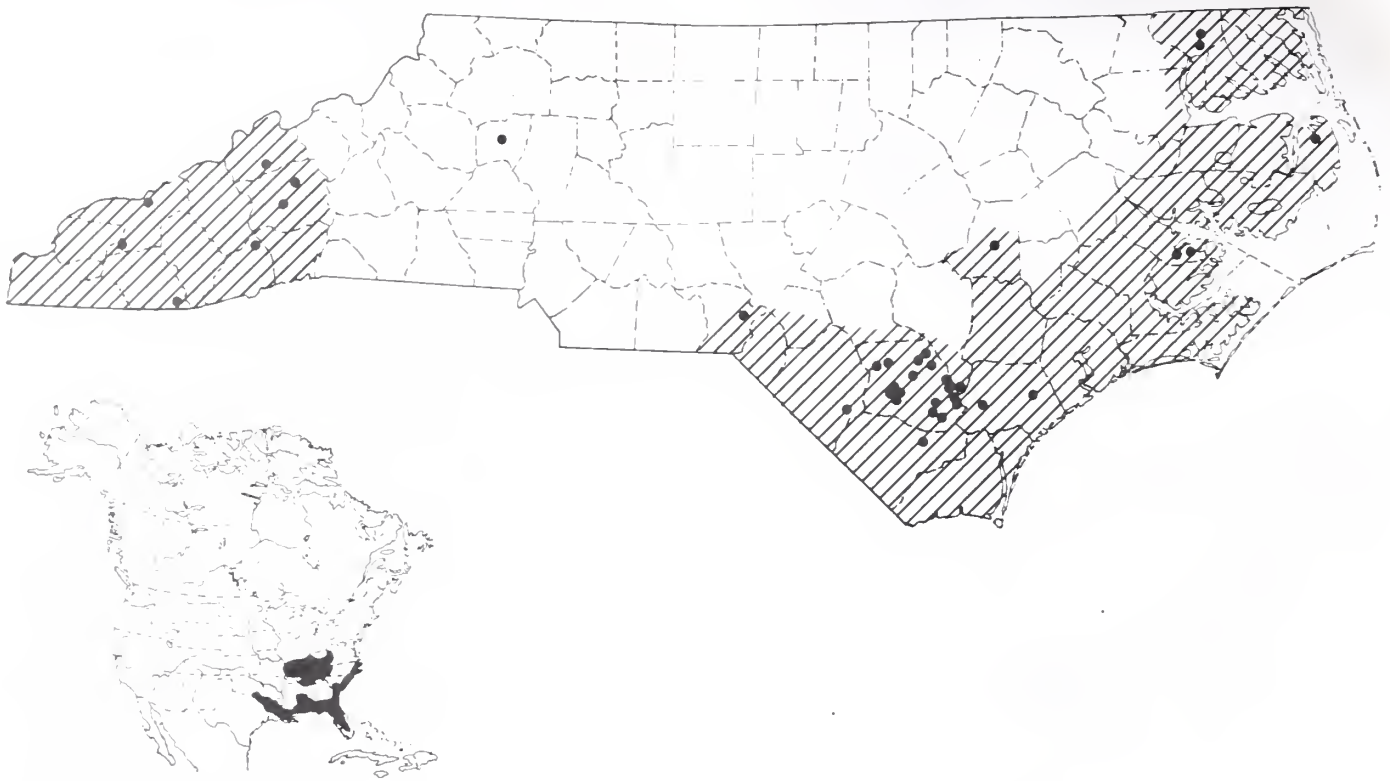


Fig. 13. Dots represent the known records of *Plecotus rafinesquii* in North Carolina. Except for the preponderance of records in Bladen County, where field work is in progress, most dots represent pre-1960 records. This bat is expected to occur only in the heavily forested, undeveloped sections of hatched areas. Total range is shown on the insert of North America.

Habitat. Natural roost sites include hollow trees and caves, but throughout its range most records of this species are from abandoned buildings. Brown (1978) states that *P. rafinesquii* has never been found to use Florida caves. Caves and mines are used by this bat in the upland parts of its range, including North Carolina. In abandoned structures this bat is found in the darkest portions of the building, preferring windowless rooms such as bathrooms and closets (pers. obs.); but in caves, areas receiving some natural light (entrances) seem to be preferred (Barbour and Davis 1969). Studies in the Coastal Plain of North Carolina indicate sites along river systems, and other permanent bodies of water, with old growth forests are preferred. Foraging habitat has not been identified.

Life History and Ecology. Most aspects of the life history and ecology of this species are poorly known. Mating is thought to occur in fall and winter. Males become solitary in the summer, and females form maternity colonies. Single young are born in May and June. Young are capable of awkward flight as early as 15 to 18 days after birth (Jones 1977).

This is a hibernating species, but the length of hibernation is not clear. In Chowan County, N.C., bats of this species were seen roosting in regularly monitored sites from March 1986 to November 1986. They were

not seen again in these sites until March 1987 (Paris Trail, pers. comm.). At some sites solitary individuals were present in the same site throughout the year.

Rafinesque's Big-eared Bat emerges to forage after dark. Foraging behavior has not been observed.

Status. Vulnerable.

Rationale for Evaluation. This species seems to occur naturally at low densities in all parts of its range. Population declines have been suggested throughout the range and are suspected in North Carolina. Several states list this bat as rare (Brown 1978, Handley et al. 1978), and it was recognized as such on a rangewide level as early as 1969 (Barbour and Davis 1969). Preliminary investigations by the NCSM in the state's Coastal Plain indicate populations there are very small. Habitat destruction, vandalism, and direct destruction of roost sites is occurring at an alarming rate. This species is listed as Category 2 by the U.S. Fish and Wildlife Service (Federal Register Vol. 50, No. 181, p. 37965).

Current Protection. There is no protection for the species on either the state or the federal level. No legislation exists to protect roost sites or other preferred habitat.

Recommendations. In North Carolina investigations in the Coastal Plain need to continue. The recent discovery of a large aggregation of *P. rafinesquii* wintering in western North Carolina (Robert Currie, USFWS, pers. comm.) suggests that much more field work is needed in the Mountain region of the state. Foraging habitat should be identified, and more information on general biology is needed to formulate effective management plans. The role of old-growth forests needs further investigation. In view of the reported declines in other parts of the range, a rangewide investigation of this species is warranted.

ACKNOWLEDGMENTS.— Paris Trail, a resident of Edenton, N.C., has been regularly monitoring roost sites of *P. rafinesquii* in Chowan County, N.C., for more than a year. His efforts have contributed significantly to our knowledge of the distribution and ecology of this bat in North Carolina. David Lee, Jeff Beane, and Danny Smith, of the N.C. State Museum, assisted in field surveys. Several summer interns, provided by the state government internship program, assisted in field work.

LITERATURE CITED

- Brown, L. N. 1978. Southeastern Big-eared Bat. Pages 1-52 in *Rare and Endangered Biota of Florida*. Vol. 1, Mammals, J. N. Layne, editor. Univ. Presses of Florida.
- Barbour, R. W., and W. H. Davis. 1969. *Bats of America*. Univ. Kentucky Press, Lexington.
- Handley, C. O., G. Tipton, and A. Tipton. 1978. Eastern Big-eared Bat. In *Proceedings of the Symposium on Endangered and Threatened Plants and Animals of Virginia*, D. W. Linzey, editor. Va. Polytech. Inst. and State Univ.
- Jones, C. 1977. *Plecotus rafinesquii*. *Mammal. Species* 69:1-4.

Prepared by MARY K. CLARK

Sciurus niger niger Linnaeus FOX SQUIRREL

Description. The Fox Squirrels of North Carolina were at one time represented by two rather distinctive forms: (1) a medium large, reddish animal, an outlier of the wide-ranging Western subspecies (*rufiventer*) and an inhabitant of the deciduous forests of the westernmost counties of the state, and (2) a very large, variably colored squirrel (*niger*) almost completely restricted to the Coastal Plain. The former is probably extirpated from North Carolina, since there have been few reports of sightings for many years. The Coastal Plain Fox Squirrel, though once the dominant tree squirrel of the eastern pine forests, is now disappearing from much of its former range, and the remainder of this species account will be devoted to this form.

The *Sciurus niger niger* of eastern North Carolina average 594 mm in length and weigh 850 to 1300 g as adults. Two color phases are common: two-thirds are some form of salt-and-pepper gray, often with a reddish, gold, or tan wash along the sides, tail, and legs and with a tan or white belly; one-third are melanistic, being almost completely black, or mostly black with a variably sized, dark gray saddle. Almost all animals have white noses, ear tips, and paws as well as dark faces and crowns. The Fox Squirrel (Fig. 14) can be distinguished from its closest relative, the Gray Squirrel (*Sciurus carolinensis*), by its size (Coastal Plain Gray Squirrels are less than half the size), long plume-like tail, distinctive coloration, and massive skull; the absence of a small set of upper premolars; and the reddish color of most of its bones (Flyger and Levin 1977).

Range. The Fox Squirrel is widely but erratically distributed in eastern North America, from New York and Minnesota south to Florida and the Gulf of Mexico and west to the front range of the Rocky Mountains and eastern Mexico (Fig. 15). This range is far from continuous, especially in the East. The squirrels of the Coastal Plain are clustered in disjunct areas of suitable habitat from Delaware to Florida and from there to eastern Louisiana. In North Carolina the Fox Squirrel's range is now restricted to parts of the southeastern counties of the state, south of the Pamlico River.

Habitat. Although Fox Squirrels may enter, and periodically reside in, practically every vegetation type found in the Coastal Plain, open, mature, mixed forest—especially Long-leaf Pine-Turkey Oak—seem to maintain the largest and most stable population (Weigl et al., in press). Such spacious, pine-oak woodlands with their discontinuous canopy and sparse understory provide not only food and nesting sites but also a refuge from many potential predators and competitors. More important than the actual tree species available in a habitat, however, is the presence of sizable oaks in the understory, large and widely scattered pines in the overstory, and periodic fires to maintain this open arrangement. Squirrels may also prosper in a mosaic of pine-oak, bottomland, and open-field habitats, providing the combined area is sufficiently large and accessible. In suboptimal areas, bottomlands and cypress swamps become increasingly important as sources of food and nesting sites, especially in the summer. Squirrels may also occupy open, mature hardwood forests, particularly if these are near agricultural plantings. Although Fox Squirrels will forage and occasionally nest in pine plantations, there is no evidence that such habitats will support stable populations without the proximity of other vegetation types.

Life History and Ecology. Until recently, so little was known about the Fox Squirrels of the eastern Coastal Plain that almost all ecological judgments and

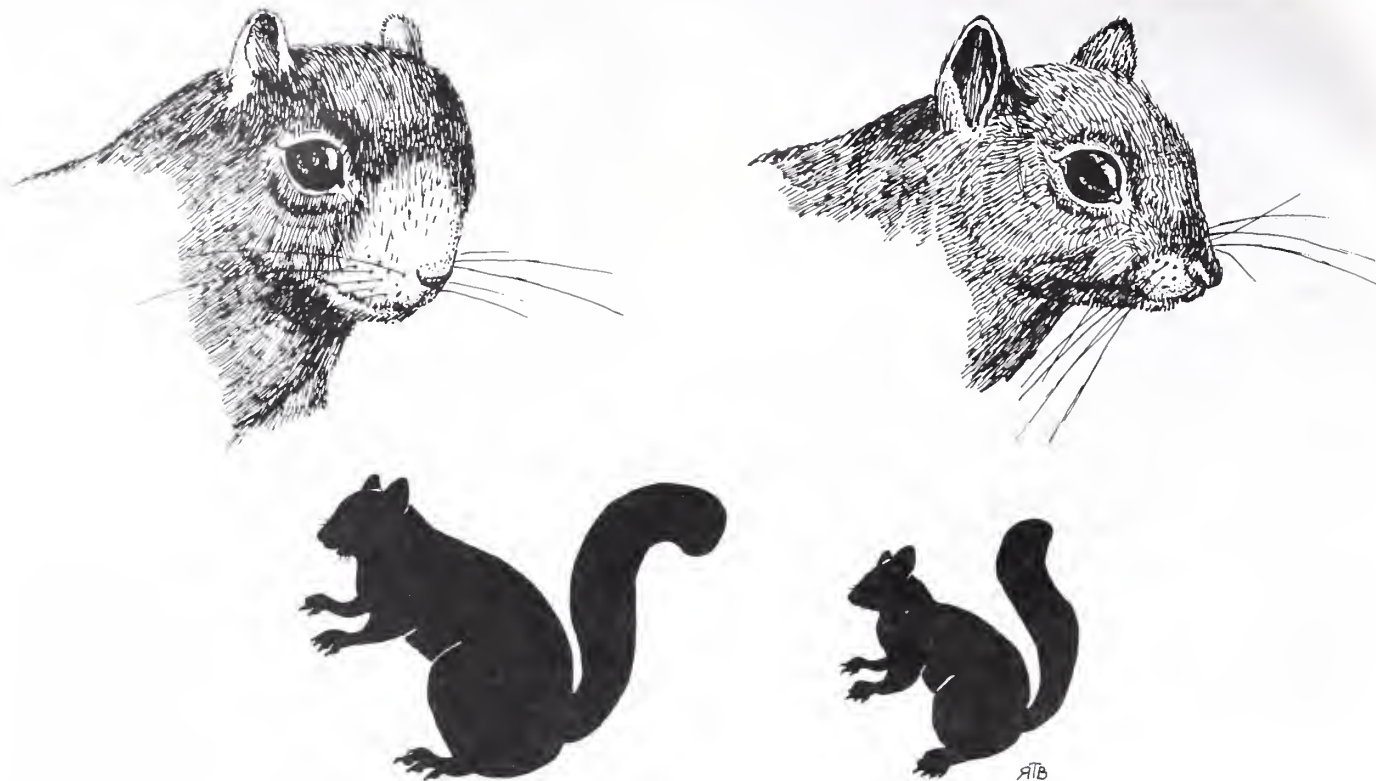


Fig. 14. The Fox Squirrel (left) is larger than the Gray Squirrel (right) and usually has white fur on the nose, ears, and paws.

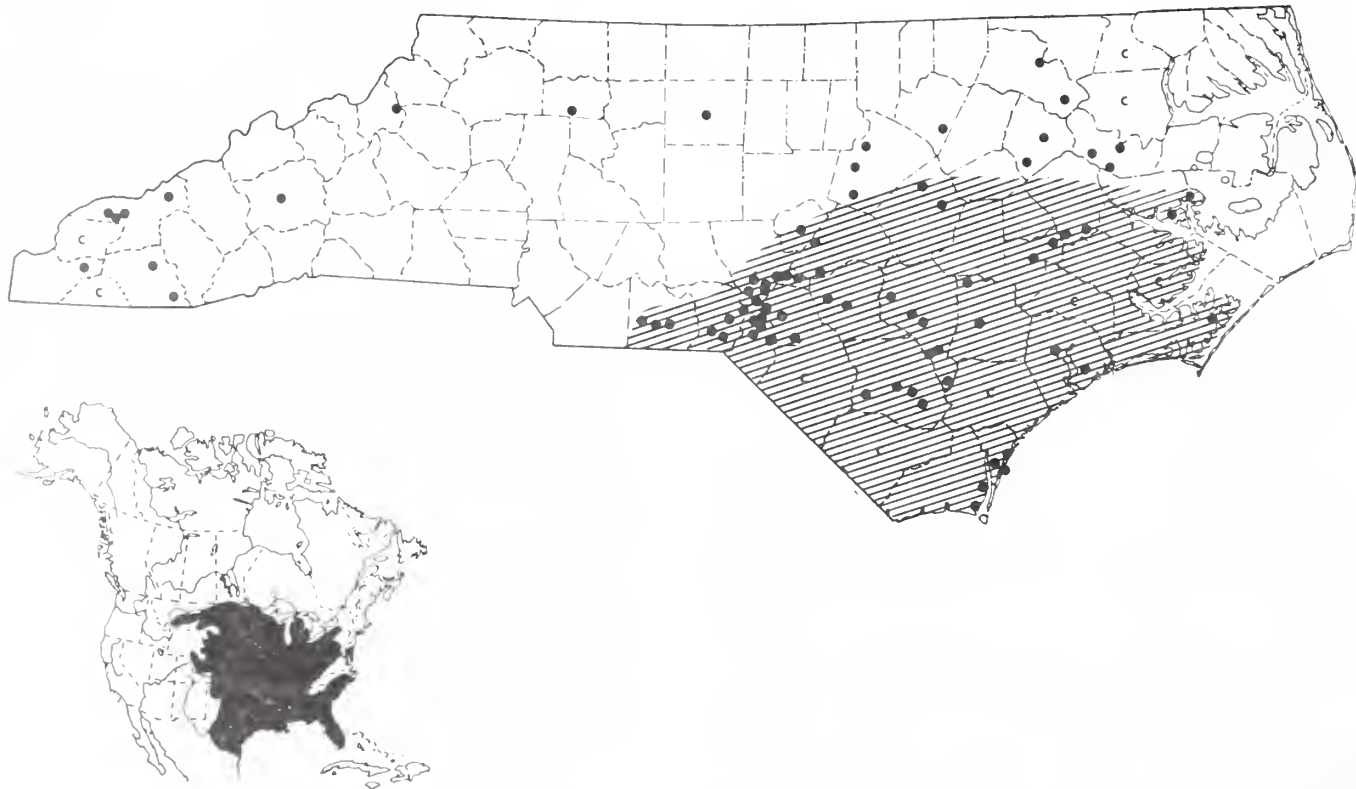


Fig. 15. The known distribution of *Sciurus niger* in North Carolina. Dots represent previously recorded specimens, and hatched areas indicate the presumed range at present. A "C" designates county records for which specific locality information is lacking. Total range of the species is shown on the insert of North America.

management decisions were based on studies of the very different forms of the Midwest. The Fox Squirrels of North Carolina occupy a low-diversity, trophically unpredictable habitat, and much of their biology seems inextricably bound to the special qualities of these open pine-oak forests. The food supplies of such habitats appear to be the dominant factor controlling squirrel populations. Over an 8-year period it became possible to predict many individual and demographic trends on the basis of food availability at certain critical periods (Weigl et al., in press). Although Fox Squirrels eat a large variety of fruits, seeds, vegetative materials, and insects, their staple foods are the seeds of various pines, especially the Long-leaf Pine, and the acorns of several species of oak. These foods are often extremely patchy in distribution, and the large size of the Fox Squirrel in the Southeast may be partially linked to the energetic efficiencies of long-distance locomotion (Gauthreaux 1980). Long-leaf Pine cones are harvested in August and September while they are green and closed. The massive bulk of these 200- to 400-g cones requires the efforts of a large seed predator, and laboratory studies reveal that of the tree squirrels only the Fox Squirrel can handle this food item with any dexterity (Weigl et al. 1981).

In addition to the pine-cone crop, Fox Squirrels depend on acorns to carry them through the fall and winter. Failure of one or both of these crops has a marked effect on the behavior, condition, and later reproduction of these squirrels, since few alternate foods are available. During periods when food is scarce and at intervals throughout the year, Fox Squirrels dig up and eat at least eight genera of hypogeous (underground) fungi, some of which are associated with pine roots. Mushrooms and other fungi are also eaten. After a spring diet of emerging plants, buds, and insects, Fox Squirrels face a period in late June and July when food is often exceptionally scarce. At this time animals appear to reduce their activity and range, lose weight, and seem to "disappear" from many of the areas where they are normally sighted. Intense activity and range adjustments are typical responses to the new crop of Long-leaf cones as the annual food cycle starts again. Studies in South Carolina (J. Edwards, pers. comm.) have revealed that squirrels having access to corn, soybeans, and other crops maintain much larger populations throughout the year than do those in natural forests.

Fox Squirrels preferentially use tree cavities for nesting during the cool months and for rearing young. Most such cavities are in large hardwoods or old pines, both of which are scarce in most pine-oak forests today. As a result, Fox Squirrels often nest in bottomlands and swamps where they must compete for cavities and food with the smaller Gray Squirrel. During the warm months, one or more compact leaf nests, or dreys, are constructed from twigs, leaves, Spanish Moss, and pine needles near the trunks of pine or hardwood trees.

Fox Squirrels in the Southeast are relatively rare and widely dispersed animals, even in areas of good habitat. Squirrel density over an 8-year period in 12 areas of North Carolina fluctuated widely but averaged 5 animals per 100 ha, with a maximum of 28 per 100 ha. This compares with estimates of 8 to 33 per 100 ha in other parts of the south (Moore 1957; Hilliard 1979; Humphrey, pers. comm., 1985). These are among the lowest densities recorded for tree squirrels (Gurnell 1983). The reproductive rate is also relatively low. Although Fox Squirrels in the midwestern United States are reported to have two litters per year, there is little evidence for individual females giving birth to more than one litter in the Southeast. In North Carolina most young are born from late February to April; a few litters have been observed in late September and October. Litter size averages 2.3 young per litter and ranges from 1 to 5. Number of litters and litter size appear closely linked to prevailing food conditions prior to mating. Except during times of mating and young-rearing, Fox Squirrels are basically asocial and nonterritorial. Individuals may cover areas of up to 50 ha to meet their basic requirements and there are frequent reports of individuals dispersing to previously unoccupied habitat. While able to move through the branches of trees like other tree squirrels, the Fox Squirrel is unique in its habit of spending considerable time on the ground and crossing open areas to reach food and new habitats. All of the above ecological characteristics seem to be the product of adaptation to open habitats with widely dispersed and rather limited resources.

Special Significance. The Fox Squirrels of North Carolina and the Southeast are the largest tree squirrels in the western hemisphere (Nowak and Paradiso 1983) and the most variably colored (Calahane 1961). Among their other special biological characteristics are their unusual clinal size variation and special adaptations for living in pine-oak habitats (Weigl et al., in press). Over much of their range they are game animals, hunted today for trophies as well as for food. Like the Red-cockaded Woodpecker (*Picoides borealis*) and a few other animals, they are a good indicator species for the status and "livability" of the Long-leaf Pine-oak forests of the South. Like these others, Fox Squirrels appear to be declining within North Carolina and much of the South.

The cause of this decline is almost completely attributable to the destruction or modification of the mature, open, pine-oak forests of the Coastal Plain. While the deforestation associated with residential and agricultural development has a clear impact on Fox Squirrel habitat, it has not always been recognized that current timber practices—the replacement of Long-leaf by Loblolly Pine, large-scale monoculture, early harvesting (25-30 year rotations), and the removal of all oaks and other hardwoods—are equally destructive. In addition, the complete suppression of fire on much private and public land has led to the development of

dense, closed-canopy forests that favor species other than the Fox Squirrel. In most areas there is little evidence that limited hunting has any major impact on Fox Squirrels as long as sufficient areas of prime habitat are available.

Status. Vulnerable.

Current Protection. The North Carolina Wildlife Resources Commission determines the intensity and location of hunting through its regulations. Otherwise, the species is protected like any other game species.

Recommendations. If the Fox Squirrel is to maintain its present limited range and its importance as a game species, two major courses of action need consideration. First, additional long-range studies of the species must be carried out in various parts of the Southeast. Because Fox Squirrels are usually rare, widely dispersed, and difficult to trap in numbers, short-term studies are completely inadequate to produce the quantity of data required for evaluating certain behavioral traits, demographic parameters, and special adaptations. Even an 8-year study, while producing considerable information, only served to indicate the scope of the investigation needed for such a long-lived animal (Weigl et al., in press). The years of research on the closely related Delmarva subspecies clearly demonstrate the difficult nature of these studies (Flyger and Lustig 1976).

A second course of action involves a rethinking of forest management practices throughout the state. Although perhaps little can be done to preserve good habitat conditions in commercial forests, many improvements can be made on private, state, and federal lands. These might include the protection of islands of old-growth pine-oak forest (see Harris 1984), the retention in the understory of 30-to-50 old oaks per ha in pine stands, the strict control of firewood cutting, regular burning programs to remove excess scrub oaks and undergrowth, and the acquisition of mature pine-oak preserves. Without management practices that protect oaks and other hardwood trees, the pine forests of the Coastal Plain will support few Fox Squirrels or the other mammals and birds dependent on these trees for food and nesting sites.

LITERATURE CITED AND SELECTED REFERENCES

- Baker, R. H. 1944. An ecological study of tree squirrels in eastern Texas. *J. Mammal.* 25:8-24.
Bangs, O. 1896. A review of the squirrels of eastern North America. *Proc. Biol. Soc. Washington* 10:145-167.
Calahane, V. H. 1961. *Mammals of North America*. The MacMillan Co., New York.
Flyger, V., and E. Y. Levin. 1977. Congenital erythropoietic porphyria. Animal model: Normal porphyria of Fox Squirrels (*Sciurus niger*). *Amer. J. Path.* 87:269-272.
Flyger, V., and L. W. Lustig. 1976. The potential for reestablishing Fox Squirrels in portions of their former

- range in the Northeastern States. *Center for Envir. and Estuarine Studies, Univ. Maryland, College Park, Contrib.* 676:13-17.
Flyger, V., and D. A. Smith. 1980. A comparison of Delmarva Fox Squirrel and Gray Squirrel habitats and home range. *Trans. Northeast. Sect., Wildl. Soc. Fish Wildl. Conf.* 37:19-22.
Gauthreaux, S. A., Jr. 1980. *Animal migration, orientation, and navigation*. Academic Press, New York.
Goodrum, P. 1938. Squirrel management in eastern Texas. *Trans. Third N. Amer. Wildlife Conf.* 670-676.
Gurnell, J. 1983. Squirrel numbers and the abundance of the seeds. *Mammalian Review* 13:133-148.
Harris, L. D. 1984. *The Fragmented Forest*. Univ. Chicago Press, Chicago, Ill.
Hilliard, T. H. 1979. Radiotelemetry of Fox Squirrels in the Georgia coastal plain. Unpubl. M.S. thesis, Univ. Georgia, Athens.
Korschgen, L. J. 1981. Foods of Fox and Gray Squirrels in Missouri. *J. Wildl. Manage.* 45:260-266.
Lowrey, G. H., Jr. 1974. *The mammals of Louisiana and its adjacent waters*. Louisiana State Univ. Press, Baton Rouge.
Lowrey, G. H., and W. B. Davis. 1942. A revision of the Fox Squirrels of the lower Mississippi Valley and Texas. *Occ. Pap. Mus. Zool., Louisiana State Univ.* 9:153-172.
Lustig, L. W., and V. Flyger. 1975. Observations and suggested management practices for the endangered Delmarva Fox Squirrel. *Proc. Southeastern Assoc. Game Fish Comm.* 29:433-440.
McComb, W. C., and R. E. Noble. 1981. Nest-box and natural-cavity use in three mid-south forest habitats. *J. Wildl. Manage.* 45:93-101.
Moore, J. C. 1956. Variation in the Fox Squirrel in Florida. *Amer. Midl. Nat.* 55:41-65.
Moore, J. C. 1957. The natural history of the Fox Squirrel, *Sciurus niger shermani*. *Bull. Amer. Mus. Nat. Hist.* 113:7-71.
Nowak, P. M., and J. L. Paradiso. 1983. *Walker's Mammals of the World*. 4th ed. Vol. II. The John Hopkins Univ. Press, Baltimore, Md.
Taylor, G. J. 1973. Present status and habitat survey of the Delmarva Fox Squirrel (*Sciurus niger cinereus*) with a discussion of reasons for its decline. *Proc. Southeastern Assoc. Game Fish Comm.* 27:278-289.
Taylor, G., and V. Flyger. 1974. Distribution of the Delmarva Fox Squirrel (*Sciurus niger cinereus*) in Maryland. *Chesapeake Sci.* 15:59-60.
Weigl, P. D., M. A. Steele, L. J. Sherman, J. C. Ha, and T. S. Sharpe. In Press. The Ecology of the Fox Squirrel (*Sciurus niger*) in North Carolina: Implications for Survival in the Southeast. *Bull. Tall Timbers Res. Sta., Tallahassee, Fla.*
Williams, K. S., and S. R. Humphrey. 1979. Distribution and status of the endangered Big Cypress Fox Squirrel (*Sciurus niger avicennia*) in Florida. *Florida Sci.* 42:201-205.

Prepared by PETER D. WEIGL

Description. This large rodent superficially resembles rats of the genus *Rattus*, but it can be easily distinguished from them (Fig. 16). The color of the pelage, though variable, usually is gray-brown above with somewhat darker hairs along the midline forming a middorsal band. The sides are buff, the head is gray, and the feet and underparts are white. The tail of mountain forms is distinctly bicolored, but that of the Coastal Plain form may be uniformly gray. The molars have enamel arranged in prismatic folds and are thus easily distinguished from the tuberculate molars of the *Rattus*. Average length is about 38 cm (15 inches) with reported sizes ranging from 30 to 43 cm (12-17 inches).

Goldman (1910) performed a complete revision of the taxonomy of the wood rats of North America, and his work remains the most comprehensive analysis of the subject available today. Since his revision, many more forms have been discovered, and the ranges of known forms have been further refined. Today a total of 10 distinct subspecies of *Neotoma floridana* are recognized. Schwartz and Odum (1957) refined the taxonomy and ranges of the six Eastern subspecies of *Neotoma floridana*.

Range. *Neotoma floridana* is a widely distributed species occurring as far west as Texas and Colorado, north along the east face of the Rockies into North Dakota, throughout the southern portions of the Great Plains, eastward through the Appalachians into southern New York, and southward into central Florida (Fig. 17). A large, unexplained hiatus in its range occurs along the eastern portions of the Mid-Atlantic States.

Three subspecies have fragmented distributions in North Carolina. *Neotoma f. floridana* occurs only in the extreme southeastern portion of the state. It was first recorded from Baldhead Island in Brunswick County by Schwartz and Odum (1957) and was later reported in Pender County by Lee et al. (1982). In the past decade, J. F. Parnell and P. Colwell, of UNC-Wilmington (pers. comm.), have attempted to redocument the species on Baldhead Island with no success. Two subspecies are in the mountain region of the state. *Neotoma f. haematoreia* (Howell) occurs in the southwestern counties and *N. f. magister* (Baird) in the northwestern counties. The zone of intergradation, if any, between these two forms is poorly defined.

Habitat. All forms of *N. floridana* build houses out of sticks, leaves, and rubbish (Fig. 18). These houses provide protection from some predators and insulation from extremes in temperature and moisture (Wiley 1980). Each house may contain two or more nests (Hall 1955) and can be quite large, many times achieving diameters in excess of 1 m. For a complete discussion of *N. floridana* houses, the reader should consult Rainey (1956). Sites are quite variable, with houses having been found along stream courses, in

shrub thickets, at the bases of trees and stumps, in subterranean chambers, in hollow logs or trees, in barns and abandoned houses, at entrances to caves, or among the rocks on talus slopes. Arboreal houses have been reported (Bangs 1898, Chamberlain 1928), but they seem to be rare.

The habitat of Coastal Plain forms of *Neotoma floridana* is generally reported to be low, wet areas, ranging from marshes (Svihla and Svihla 1933) to swamps and swamp hammocks (Bangs 1898, Harper 1927, Chamberlain 1928, Hamilton 1953). Pearson (1952) reported that the greatest abundance of *N. f. floridana* in Florida occurred in the ecotones between high and low hammock communities. The one known colony of this subspecies in North Carolina does not occur in a wet habitat, but rather in association with scattered trash in an oak-pine forest. Both *N. f. haematoreia* and *N. f. magister* are normally associated with rocky places and abandoned buildings at elevations above 3000 feet (900 m). Detailed habitat information is lacking for all subspecies occurring in North Carolina.

Life History and Ecology. *Neotoma floridana* is nocturnal and active throughout the year (Wiley 1980). Wood rat social structure has been well studied. Although many authors have noted the colonial nature of the species, Eastern Wood Rats appear to be solitary in behavior (Murphey 1952), sharing their houses only during the breeding season and when rearing young. The breeding season for *Neotoma floridana* appears to vary geographically. No studies of the reproduction of this species have been performed in North Carolina. Reports from Florida (Pearson 1952, Hamilton 1953) and coastal Georgia (Golley 1962) indicate that breeding takes place throughout the year. Home ranges of wood rats appear to be variable (Fitch and Rainey 1956) but usually occupy less than 0.5 ha (Goertz 1970). Fluctuations in wood rat populations have been tied to abundances in acorn crops by Neal (1967) and to extreme weather conditions by Fitch and Rainey (1956). Studies of food habits have shown that wood rats have a varied diet and that no single plant species makes up the bulk of their diet. The reader is directed to Rainey (1956), Pearson (1952), and Wiley (1980) for information on food habits.

The effect of predation on North Carolina's wood rats is unknown. In summarizing predation on *Neotoma*, Wiley (1980) surmizes that the Black Rat Snake (*Elaphe obsoleta*) and the Long-tailed Weasel (*Mustela frenata*) are probably their most formidable predators because their size allows them to enter *Neotoma* houses. *Neotoma floridana* has been shown to suffer from a wide range of ecto- and endoparasites. The most commonly reported ectoparasites are warble (bot) fly larvae, fleas, ticks, and mites (Murphey 1952). The effects of these parasites on *Neotoma* populations is unknown; however, circumstantial evidence indicates that an outbreak of ticks may have been responsible for the extirpation of *Neotoma* from the vicinity of Oak



Fig. 16. *Neotoma floridana* (b) is smaller than *Rattus* spp. (a) but larger than the Cotton Rat, *Sigmodon hispidus* (c). *Rattus* spp. have a sparsely haired, scaly tail (d) in comparison with the shorter, furry, and often bicolored tail of *N. floridana* (e).

Lodge near Cape Canaveral, Fla. (David S. Lee, pers. comm.). The most common endoparasites of *Neotoma* were reported by Murphey (1952) to be nematodes and helminths.

Special Significance. North Carolina's populations of *Neotoma* have special significance in that they provide opportunities to study three subspecies on the edges of their ranges. The northern extent of *N. f. floridana* is reached in the southern Coastal Plain and the limiting factors for the species in this area are unknown. The

closest known colony to the Pender County population is in Georgetown County, S.C. (Sanders 1978); thus, the North Carolina population may represent a gene pool isolated by a distance of more than 160 km. The ranges of *N. f. haematoreia* and *N. f. magister* both reach their limits in the mountains of North Carolina, where areas of potential range overlap and competition need to be investigated. Birney (1976) discussed physical and behavioral evidence indicating that *N. f. magister* may be a biological species separate from *N. floridana*. Research to clarify this situation is needed.

Status. *Neotoma floridana floridana*, Vulnerable; *N. f. haematoreia* and *N. f. magister*, Undetermined.

Rational for Evaluation. The status of the populations of all three subspecies occurring in North Carolina is uncertain. Only one population of *N. f. floridana* is known to exist in southeastern North Carolina, and its numbers have declined markedly in recent years (David S. Lee, pers. comm.). Only two records of *N. f. magister* and eleven of *N. f. haematoreia* are known from the state. Most of the Mountain records are scattered, both spatially and temporally, and have not been verified in recent years.

Population cycles and dispersal behavior for *Neotoma* are unknown. Modification of habitat in the vicinity of colony sites may be occurring so rapidly that *Neotoma* populations do not have an opportunity to increase or to emigrate into other suitable areas. Population levels of *N. f. floridana* in the state are probably so low that significant dispersal is impossible.

Current Protection. One isolated member of the *N. floridana* group, *N. f. smalli* (Sherman), is restricted to portions of Key Largo and Lignumvitae Key, Fla. Because of diminished numbers and continuing widespread habitat destruction, this subspecies was listed as Endangered by the U.S. Fish and Wildlife Service in 1984. No North Carolina members of the *N. floridana* group are currently protected.

Recommendations. Surveys should be undertaken to discover new populations of *Neotoma*, if any, in the mountains and especially in the Coastal Plain. The likelihood of finding new colonies in the mountains is probably good, whereas the outlook is bleak in the Coastal Plain. The only known site for *N. f. floridana* needs to be protected from habitat modification, and collection of specimens should be restricted until a proper assessment of this subspecies' status in the state can be made. Future surveys for *N. f. floridana* may be most productive in areas that have received minimal disturbance from fire and logging. The effect of fire on *Neotoma* colonies in other areas should also be investigated. Chamberlain (1928) noted the destruction of some *Neotoma* houses by fire and, given its widespread use as a forest management tool today, the range of its effects on the species needs to be better understood.

ADDENDUM

Much of the *N. f. floridana* colony site in Pender County underwent selective timber harvest early in 1987. Most of the mast-producing trees and shrubs were removed, and the site is now dominated by pines. The fate of this colony has not been assessed, but the magnitude of the habitat alterations has probably destroyed the colony. With this loss, the subspecies may now be extirpated from the state.

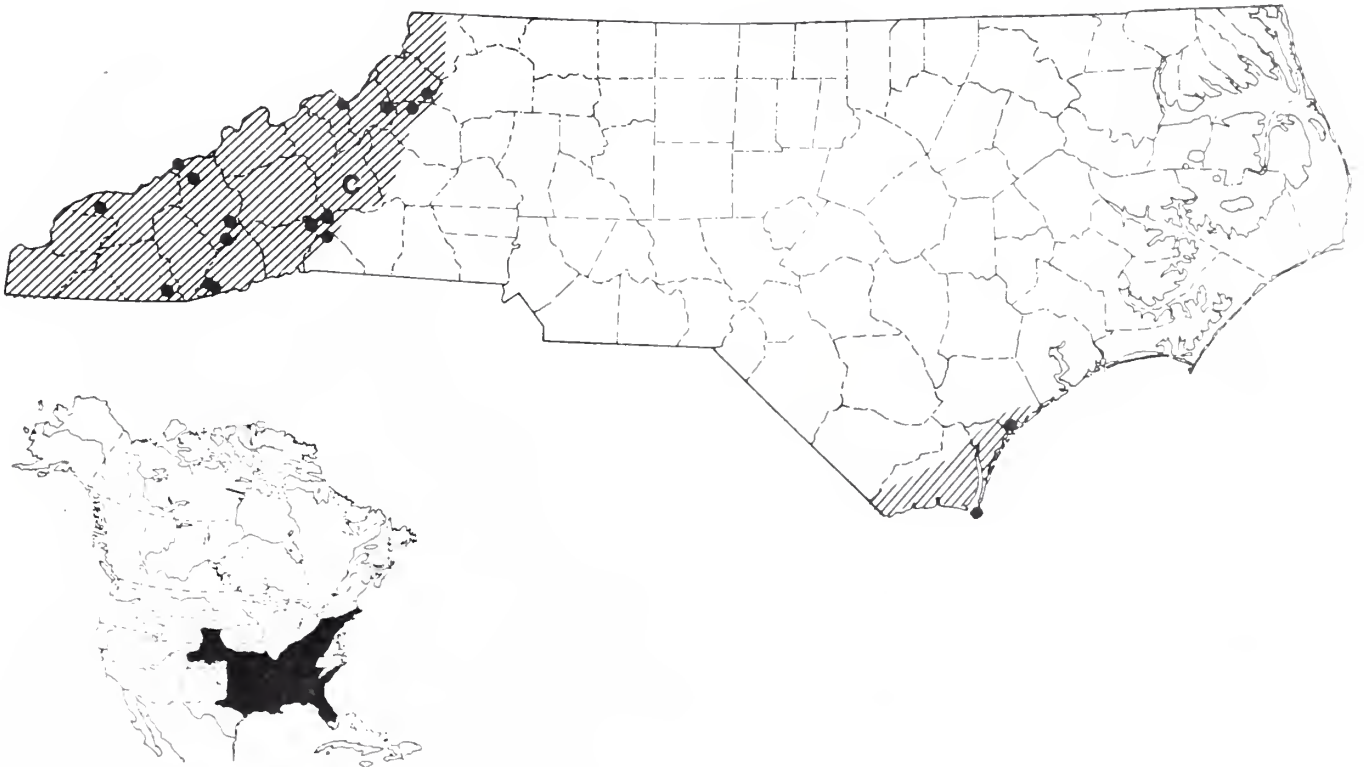


Fig. 17. The known distribution of *Neotoma floridana* in North Carolina. Dots represent previously recorded specimens, and hatched areas indicate the presumed range. A "C" designates county records for which specific locality information is lacking. Total range of the species is shown on the insert of North America

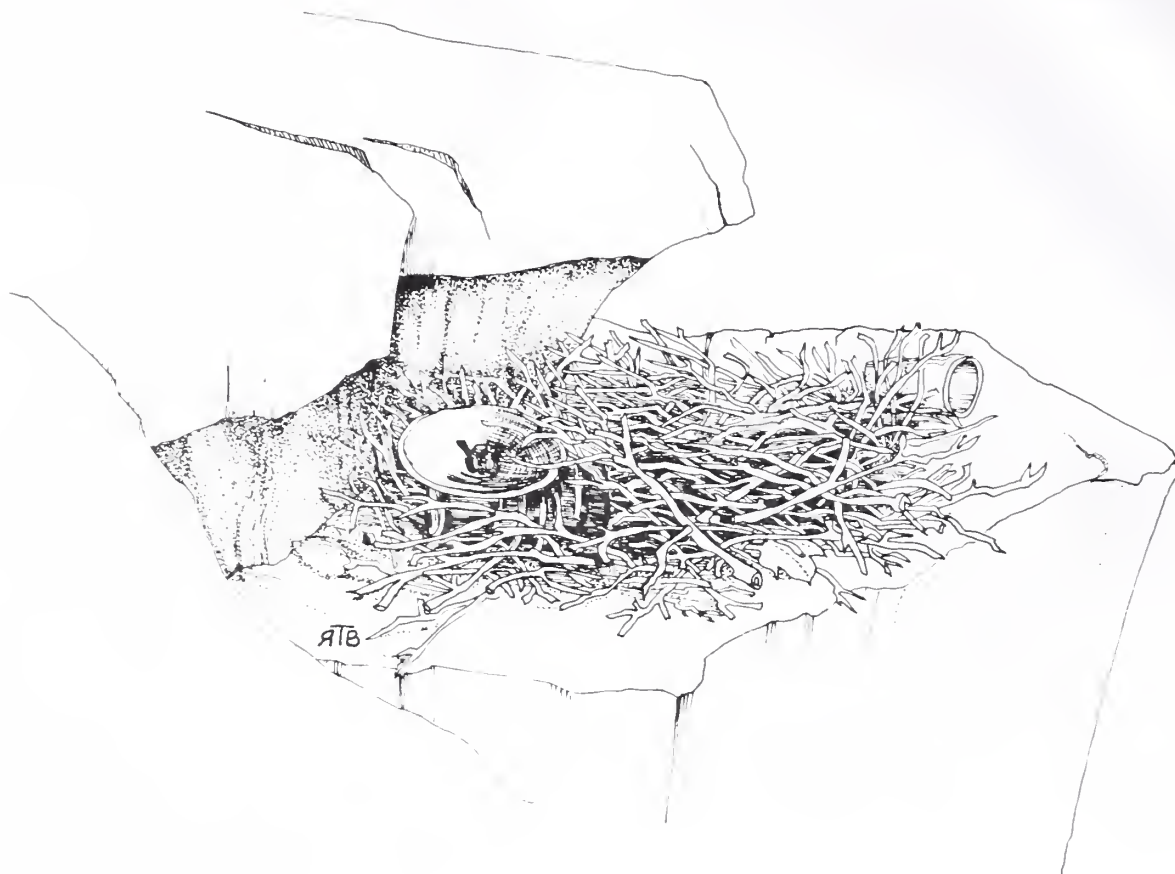


Fig. 18. Stick nest of the Eastern Wood Rat, *Neotoma floridana*.

LITERATURE CITED

- Bangs, O. 1898. The land mammals of peninsular Florida and the coast region of Georgia. Proc. Boston Soc. Nat. Hist. 28:157-235.
- Birney, E. C. 1976. An assessment of relationships and effects of interbreeding among woodrats of the *Neotoma floridana* species-group. J. Mammal. 57:103-132.
- Chamberlain, E. B. 1928. The Florida Wood Rat in South Carolina. J. Mammal. 9:152-153.
- Fitch, H. S., and D. G. Rainey. 1956. Ecological observations on the woodrat, *Neotoma floridana*. Univ. Kansas Publ., Mus. Nat. Hist. 8:499-533.
- Goertz, J. W. 1970. An ecological study of *Neotoma floridana* in Oklahoma. J. Mammal. 51:94-104.
- Goldman, E. A. 1910. Revision of the wood rats of the genus *Neotoma*. N. Amer. Fauna 31:1-124.
- Golley, F. B. 1962. Mammals of Georgia. Univ. Georgia Press, Athens.
- Hall, F. R. 1955. Handbook of Mammals of Kansas. Univ. Kansas Publ., Mus. Nat. Hist. 7:1-303.
- Hamilton, W. J., Jr. 1953. Reproduction and young of the Florida Wood Rat, *Neotoma f. floridana* (Ord). J. Mammal. 34:180-189.
- Harper, F. 1927. The mammals of the Okefinokee Swamp region of Georgia. Proc. Boston Soc. Nat. Hist. 38:191-396.
- Lee, D. S., J. B. Funderburg, Jr., and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. Occas. Pap. N.C. Biol. Surv.
- Murphey, M. F. 1952. Ecology and helminths of the Osage Wood Rat, *Neotoma floridana osagensis*, including description of *Longistriata neotoma* n. sp. (Trichostrongylidae). Amer. Midl. Nat. 48:204-218.
- Neal, W. A. 1967. A study of the ecology of the woodrat in the hardwood forests of the lower Mississippi River Basin. Unpubl. M.S. thesis, Louisiana State Univ., Baton Rouge.
- Pearson, P. G. 1952. Observations concerning the life history and ecology of the wood rat *Neotoma floridana floridana* (Ord). J. Mammal. 33:459-463.
- Rainey, D. G. 1956. Eastern Woodrat, *Neotoma floridana*: life history and ecology. Univ. Kansas Publ., Mus. Nat. Hist. 8:535-646.
- Sanders, A. E. 1978. Mammals. Pages 296-308 in An Annotated Checklist of the Biota of the Coastal Zone of South Carolina, R. G. Zingmark, editor. Univ. South Carolina Press, Columbia.
- Schwartz, A., and E. P. Odum. 1957. The woodrats of the eastern United States. J. Mammal. 38:197-206.
- Svihla, A., and R. D. Svihla. 1933. Notes on the life history of the woodrat, *Neotoma floridana rubida* (Bangs). J. Mammal. 14:73-75.
- Wiley, R. W. 1980. *Neotoma floridana*. Mammal. Species 139:1-7.

Prepared by WILLIAM F. ADAMS

Description. Black Bears are large mammals with heavy bodies and thick, sturdy legs. In most places weights range from 40 to 140 kg, with females generally smaller than males. An occasional male can weigh up to 300 kg. Each foot has five toes, and posture is plantigrade. An adult bear usually stands about 60 to 90 cm at the shoulders and is 1.5 to 2 m in total length. The tail is very short. Ears are small and round; eyes are brown. The dental formula is I3 3, C1 1, P4 4, M2 3 = 42, end teeth are bunodont, reflecting the animal's catholic diet. Most Black Bears are uniformly black except for a brown muzzle, brown spots sometimes over the eyes, and white sometimes on the chest or paws. In western North America a brown color phase is found, and a gray color phase occurs on the north Pacific coast. These color patterns are very similar to those found in domestic dogs (*Canis familiaris*) and appear to be inherited as described by Little (1957).

Distribution. The original range of the Black Bear covered the entirety of North America (Hall 1981). Its present range is generally limited to extensively forested areas with little human settlement, though healthy Black Bear populations persist in places where humans cause little disturbance. The most extensive, contiguous areas with Black Bears are now in Canada and Alaska (Fig. 19). Originally found throughout North Carolina, Black Bears are now restricted to patches of sparsely settled land in the mountains in the western part of the state and on the Coastal Plain in the east.

Habitat: When not disturbed by humans, Black Bears are surprisingly adaptable in their habitat requirements. However, in most areas, North Carolina included, local bear populations without refuge from interactions with humans decline and become extirpated. The best bear habitat is usually characterized by inaccessible terrain, thick understory, vegetation for refuge, and trees and shrubs that produce an abundance of hard and soft mast for food (Pelton 1982). As human populations expand into bear habitat, refuge and food become critical if bear populations are to survive (Landers et al. 1979). Extensive pocosins on the Coastal Plain (Landers et al. 1979) and roadless areas in the mountains will be exceedingly important to future Black Bear populations in North Carolina.

Life History and Ecology. Black bears are born during January while the mothers are in their winter dens. Cubs weigh 200 to 300 g at birth and are exceedingly altricial for eutherian mammals (Hayssen et al. 1985). Mothers and cubs do not leave the den until April or May, and cubs are dependent on their mothers throughout their first active season. Mothers and cubs usually den together until cubs are approaching 1 year of age and weigh between 15 and 30 kg. Cubs then become independent sometime after leaving the

den, when they are more than 1 year old. Thus females generally produce litters once every 2 years. With proper nutrition, females usually reach adult weight and sexual maturity when $3\frac{1}{2}$ years old, though there is some evidence that $2\frac{1}{2}$ -year-old females sometimes breed in North Carolina (Carlock et al. 1983). In times of food shortage or in areas with low food productivity, females may delay sexual maturity until they are $5\frac{1}{2}$ or older. Males may reach sexual maturity at $3\frac{1}{2}$ as well, but they usually do not become active breeders until several years older. Individuals may not reach full size until 8 years old or older.

Although Black Bears are considered omnivorous and eat a wide variety of foods, they are still quite selective in what they eat. Bears can be active predators on live prey, mostly mammals; but because they are large and lack the specializations of other members of the order Carnivora for capturing active prey, they rely mostly on insects, larvae, honey, and plant foods. As carnivores, bears have short digestive tracts best suited to digesting meat and other animal protein (Ewer 1973); therefore, they must be selective in the plant foods they do eat. Bears eat fruits, nuts, young leaves, and other plant parts that are easy to digest and that are not heavily protected with secondary plant compounds. American Chestnut (*Castanea dentata*) was an important fall food before the chestnut blight essentially eliminated that species. From season to season and from year to year, Black Bear foods change in abundance and nutritional quality. Thus bears are adapted to finding new and novel food sources as their old ones change and disappear on a seasonal and yearly basis. Bears' use of human foods found at dumps, at campsites, and along roads is an expression of their adaptability, though use of these particular food sources can be detrimental to bears through negative interactions with humans.

Size and overlap of Black Bear home ranges vary considerably between the sexes and in different parts of the species, range (Garshelis and Pelton 1981, Lindzey and Meslow 1977, Powell 1986, Rogers 1977). Home ranges for adult male bears in the mountains of North Carolina average around 60 km², whereas female home ranges are about one-third as large (Warburton 1984). Home ranges of bears living on the North Carolina Coastal Plain are considerably smaller (Landers et al. 1979). In northern habitats, adult females appear territorial towards other adult females (Rogers 1977), but in southern populations there is considerable home-range overlap among females (Garshelis and Pelton 1981, Powell 1986). This difference in territorial behavior is probably in response to differences in food productivities in patchy environments (Powell 1986). Adult males have larger home ranges than do females and are also more mobile on a daily and yearly basis. Seasonal and yearly variations in production of hard and soft mast lead to differences in movements. During food shortages, bears have been known to travel long

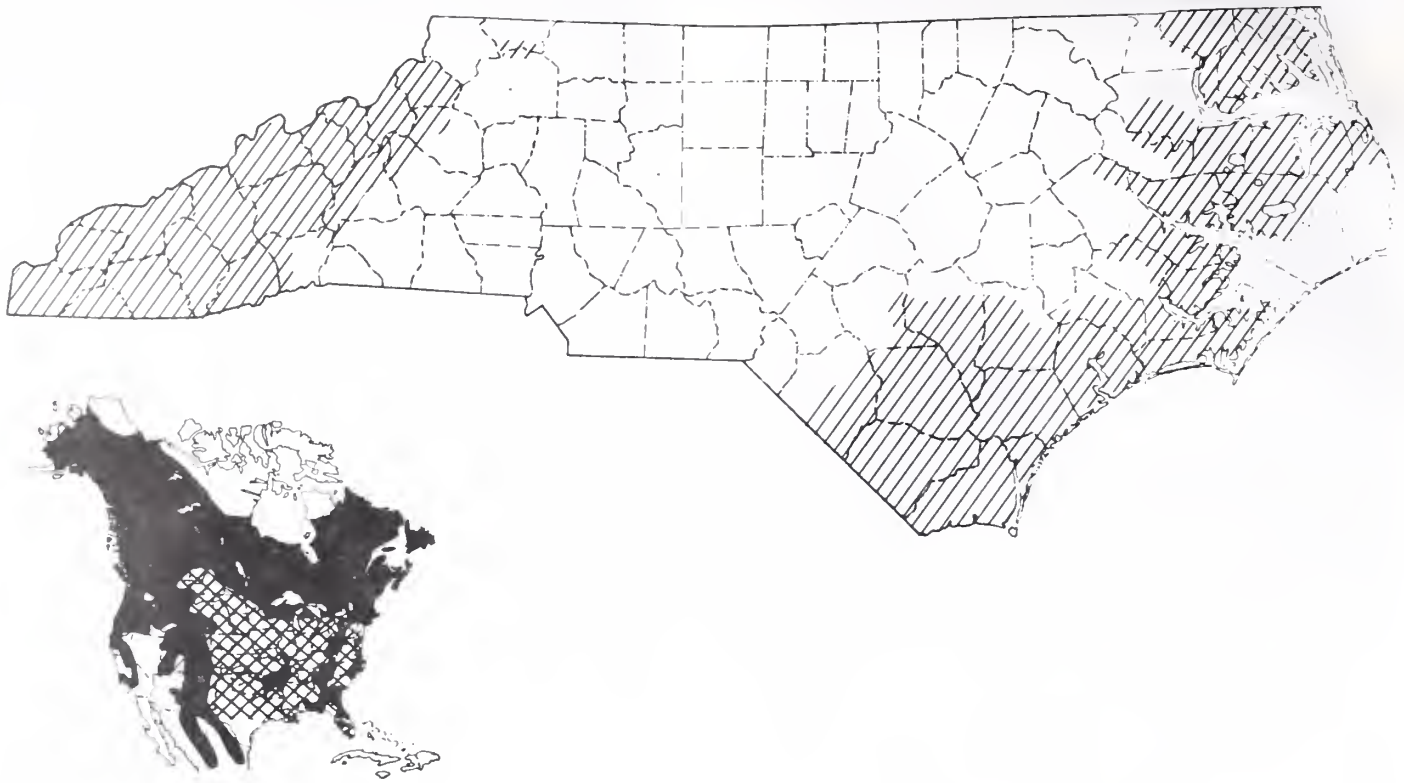


Fig. 19. Historically the Black Bear, *Ursus americanus*, ranged throughout the state, but the range is now much reduced (hatched area). The North American map shows the present (solid areas) and historic (solid areas combined with crosshatched) ranges. Within the present range, bears are not found within areas of high human density.

distances to find patches of abundant food (Rogers 1977). Bears can be active at any time of the day, though there may be differences in times of predominant activity during different seasons and in different parts of the species' range.

Bears den in fall or early winter and use a variety of den types. North Carolina bears den in sheltered beds such as hollow trees, in small caves, under fallen trees, and in unsheltered beds. A month or two before bears actually enter a den, their physiology begins to show changes toward that typical of denning bears; and for the last month before denning, bears may eat little or nothing (Nelson et al. 1984). Pregnant adult females usually enter dens first and adult males last (O'Pezio et al. 1983). While denned, northern bears do not eat, drink, urinate, or defecate, and their body temperatures and metabolic rates are low (Nelson et al. 1973). In North Carolina, however, bears are occasionally active and may defecate while denned. Though there is usually significant weight loss during winter, mostly from catabolism of fat, there is actually a slight increase in nonfat weight through recycling of nitrogen from urine to protein (Nelson et al. 1983). Chronology of den emergence is the reverse of that for den entry. In North Carolina denning does not appear to be obligatory except for pregnant females (Powell, unpubl. data). Though North Carolina bears exhibit physiology typical

of denned bears, adult males and juveniles of both sexes may change dens several times during the winter and may never settle in one place for more than a few days. Such bears are easily flushed from their resting places by approaching humans.

Special Significance. Bears are large, wild mammals and as such are important as game and as symbols of wilderness (Hendee and Schoenfeld 1978). Bears have always been hunted in North Carolina, and groups with specific interests in hunting for bears have developed, especially in the mountains. Many non-hunters also enjoy seeing Black Bears while vacationing in wild areas largely unaffected by humans. The continued existence of bears in the state is thus important to both the hunting and non-hunting public.

Status. Vulnerable.

Rationale for Evaluation. Black Bear populations have declined in North Carolina in direct relationship to the extent of their interactions with humans. Existing populations are confined to areas with limited human populations. These bear populations are vulnerable to the extent that their habitat is threatened, especially habitat for refuge. Rapid human population growth in coastal North Carolina will affect bear populations as pocosins are drained and cleared. In the mountains, human population growth and forestry practices will



affect bear populations to the extent that human access to remote areas is increased. Historically, bears have not been able to coexist with humans in North Carolina even though they have in other parts of North America. Thus we should anticipate that Black Bears and humans will not be able to share habitat extensively in North Carolina in the future.

The sex ratio of bears harvested legally each year has recently been skewed toward males, and the age distribution of harvested bears indicates that the population is skewed toward young animals. These are characteristics typical of populations that are well below their carrying capacities. Finally, in some areas of North Carolina, poaching appears to be a major mortality factor and one that may be causing some populations to decline. As long as this continues, the affected populations are threatened. Thus it appears that North Carolina could support a considerably larger Black Bear population than it now does.

Current Protection. Bears are managed as big-game mammals by the North Carolina Wildlife Resources Commission. Bear hunting is legal in specified areas in the Appalachian Mountains and Coastal Plain, and the season bag limit and season length are presently (1986) set at one bear and 45 days. The Wildlife Resources Commission has the authority to change these regulations to increase protection of bears when it believes increased protection is necessary. Estimated annual legal harvest has been around 300 to 400 animals during recent years.

There are presently 28 Black Bear sanctuaries in North Carolina sponsored by the Wildlife Resources Commission in cooperation with various land-owning

federal and state agencies. The Great Smoky Mountains National Park and the Blue Ridge Parkway are also sanctuaries. Within these sanctuaries it is illegal to kill Black Bears though in most of the Wildlife Resources Commission sanctuaries hunting of other game is legal, including hunting some game with dogs and running dogs for practice. This makes poaching difficult to control. The goal of these sanctuaries is to protect core breeding populations of Black Bears that will produce a dispersing surplus of bears that can be hunted outside the sanctuaries. Thus, conceptually, the sanctuaries meet long-term and short-term goals for Black Bear management by maintaining viable populations in the state and by permitting an annual harvest. The sanctuaries also conceptually meet the interests of the hunting and non-hunting public by protecting "crucial" bear populations in some places while allowing hunting in other places.

The U.S. Forest Service has designated the Black Bear as an indicator species in its forest management plans for North Carolina, and in individual National Forest districts logging roads have been closed to limit access to important Black Bear habitats. Because there is no legal hunting on lands managed by the National Park Service, the Great Smoky Mountains National Park and the Blue Ridge Parkway will continue to give Black Bears as much protection as is financially feasible.

Remarks. Information on Black Bears has been reviewed by Burt and Grossenheider (1976), Jonkel (1978), Pelton (1982), and Nowak and Paradiso (1983).

LITERATURE CITED

- Burt, W. P., and R. P. Grossenheider. 1976. A Field Guide to the Mammals. Houghton Mifflin Co., Boston.
- Carlock, D. M., R. H. Conley, J. M. Collins, P. E. Hale, K. G. Johnson, A. S. Johnson, and M. R. Pelton. 1983. The Tri-State Bear Study. Tennessee Wildl. Res. Auth. Tech. Rep. 83-9.
- Ewer, R. F. 1973. The Carnivores. Cornell Univ. Press, Ithaca, N.Y.
- Garshelis, D. L., and M. R. Pelton. 1981. Movements of Black Bears in the Great Smoky Mountains National Park. J. Wildl. Manage. 45:912-925.
- Hall, E. R. 1981. Mammals of North America. 2nd ed. John Wiley and Sons, New York.
- Hayssen, V., R. C. Lacy, and P. J. Parker. 1985. Metatherian reproduction: Transitional or transcending? Amer. Nat. 126:617-632.
- Hendee, J. C., and C. Schoenfeld. 1978. Wildlife in wilderness. Pages 214-247 in Wilderness Management, J. C. Hendee, G. H. Stankey, and R. C. Lucas, editors. USDA Forest Service Misc. Pub. No. 1365.
- Jonkel, C. 1978. Black, Brown (Grizzly), and Polar Bears. Pages 226-248 in Big Game of North America, J. L. Schmidt and D. L. Gilbert, editors. Stackpole Books, Harrisburg, Pa.
- Landers, J. L., R. J. Hamilton, A. S. Johnson, and R. L. Marchington. 1979. Foods and habitat of Black Bears in southeastern North Carolina. J. Wildl. Manage. 43:143-153.

- Lindzey, F. G., and E. C. Meslow. 1977. Home range and habitat use by Black Bears in southwestern Washington. *J. Wildl. Manage.* 41:413-425.
- Little, 1957. *The Inheritance of Coat Color in Dogs*. Howell Book House, New York.
- Nelson, R. A., T. D. I. Beck, and D. L. Steiger. 1984. Ratio of serum urea to serum creatinine in wild Black Bears. *Science* 226:841-842.
- Nelson, R. A., D. L. Steiger, and T. D. I. Beck. 1983. Neuroendocrine and metabolic interactions in the hibernating Black Bear. *Acta Zool. Fenn.* 174:137-141.
- Nelson, R. A., H. W. Wahner, J. D. Jones, R. D. Ellefson, and P. E. Zollman. 1973. Metabolism of bears before, during, and after winter sleep. *Amer. J. Physiol.* 224:491-496.
- Nowak, R. M., and J. L. Paradiso. 1983. *Walker's Mammals of the World*. 4th ed. The Johns Hopkins Univ. Press, Baltimore, Md.
- O'Pezio, J., S. H. Clarke, and C. Hackford. 1983. Chronology of denning by Black Bears in the Catskill Region of New York. *N.Y. Fish Game J.* 30:1-11.
- Pelton, M. R. 1982. Black Bear (*Ursus americanus*). Pages 504-514 in *Wild Mammals of North America*, J. A. Chapman, and G. A. Feldhamer, editors. The Johns Hopkins Univ. Press, Baltimore, Md.
- Powell, R. A. 1986. Black Bear (*Ursus americanus*) home range overlap in North Carolina. *Internatl. Conf. Bear Res. Manage.* 7: in press.
- Rogers, L. L. 1977. Movements and social relationships of Black Bears in northeastern Minnesota. Ph.D. dissert. Univ. Minnesota, St. Paul.
- Warburton, G. S. 1984. An analysis of a Black Bear sanctuary in western North Carolina. M.S. thesis. N.C. State Univ., Raleigh.

Prepared by ROGER A. POWELL

UNDETERMINED

Sorex palustris punctulatus Hooper APPALACHIAN WATER SHREW

Description. The Water Shrew is the largest long-tailed shrew (genus *Sorex*) known from North Carolina (Fig. 20); its body size approaches that of the northern Short-tailed Shrew (*Blarina brevicauda*), but the distinctly bicolored tail of *Sorex palustris* is more than two-thirds the head and body length (rather than less than half the head and body length as in *B. brevicauda*). The Water Shrew's hind feet are enlarged, webbed, and distinctly fringed with stiff hairs along the side and toes. Dense blackish fur nearly conceals the small eyes and short pinnae. The dental formula for the Water Shrew is $3\ 1, 1\ 1, 3\ 1, 3\ 3 = 32$. Selected external measurements (in mm), with means in parentheses, of six *S. palustris* from North Carolina, which herein are allocated tentatively to *S. palustris punctulatus* pending a review of the ostensibly isolated populations in the southern Appalachians, are: total length, 113-160 (142.2); length of tail, 55-68 (61.8); and length of hind foot, 18-20 (19.2) (Linzey 1983, Whitaker et al. 1975).

Range. The Water Shrew is known from much of Canada and Alaska (except most of the tundra zone) southward throughout the Sierra Nevadas in California, the Rocky Mountains to Arizona and New Mexico, and the Appalachian Mountains to Tennessee and North Carolina (Fig. 21). In North Carolina it is represented by five specimens from a small section of Fires Creek in Clay County at an elevation of 1225 m (Whitaker et al. 1975) and one specimen from Beech Flats Creek in the Great Smoky Mountains (Swain County) at an elevation of 1290 m (Linzey 1983). This shrew may occur elsewhere in the mountains of North Carolina, for it has also been taken above 625 m in the Great Smoky Mountains in Sevier County, Tenn. (Conaway and Pfitzer 1952; Linzey and Linzey 1971, 1973; Linzey 1983), and cryptically reported from an unspecified locality in Swain County, N.C. (Smith et al. 1960).

Habitat. These semiaquatic shrews have been taken along fast-moving streams and in surrounding forests of Eastern Hemlock (*Tsuga canadensis*), Yellow Birch (*Betula lutea*), Red Spruce (*Picea rubens*), and Yellow Poplar (*Liriodendron tulipifera*), with and without dense understories of Great Laurel (*Rhododendron maximum*).

Life History and Ecology. The only natural history information pertaining to Water Shrews in North Carolina was given by Linzey (1983) and Whitaker et al. (1975). Specimens have been taken among moss-covered rocks and logs and on gravel shores, and never far from small creeks. The stomach contents of five Water Shrews from North Carolina contained 83% aquatic insects (stonefly naiads, mayfly naiads, and caddis fly larvae) and 17% harvestmen. These shrews were parasitized by several species of mites, chiggers, ticks, and fleas. A female taken on 20 April carried five embryos.

Status. Undetermined.

Rationale for Evaluation. *Sorex p. punctulatus* is listed as Endangered in Virginia (Handley 1980) and Undetermined in Maryland (Feldhamer et al. 1984), Pennsylvania (Enders 1985), and North Carolina (Lee and Funderburg 1977). Its listing herein remains as Undetermined because the extent of its geographic distribution, local habitat requirements, and population dynamics in the western mountains are unknown. Based on records of capture from other parts of its geographic range, the Water Shrew can be considered an indicator species because of its propensity for swiftly flowing streams in pristine montane habitats.

As mentioned earlier, the Water Shrew apparently occurs in isolated pockets in the southern Appalachians. Specimens assignable to *S. p. punctulatus* have been taken in West Virginia (Hooper 1942, Handley 1980), Virginia (Pagels and Tate 1976), and Pennsylvania (Doutt et al. 1973). Specimens from southwestern North Carolina and southeastern Tennessee, however, are

Sorex hoyi



Sorex longirostris



Sorex dispar



Sorex palustris

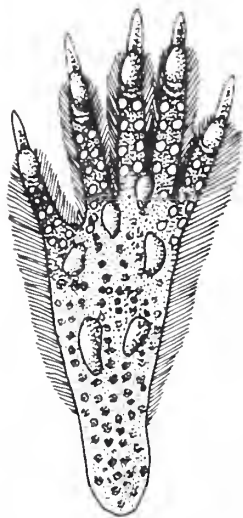


Fig. 20. Size differences in *Sorex* spp. described in accounts. The hind feet of *S. palustris* are fringed with stiff hairs.

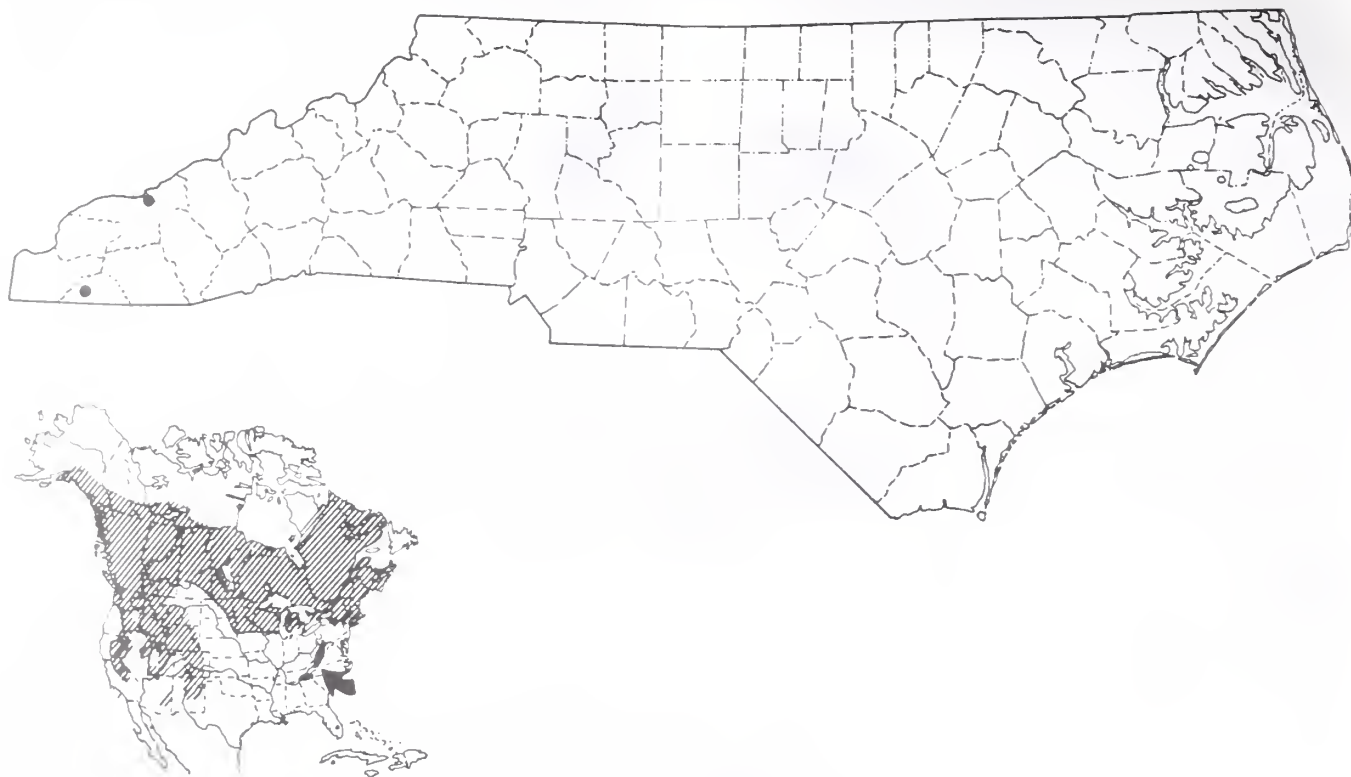


Fig. 21. In North Carolina *Sorex palustris* is known from only two sites. Total range of the species is shown on the insert of North America. The disjunct race *S. p. punctulatus* is confined to the southern Appalachians (solid area).

separated from this mid-Atlantic population by approximately 300 km, and a formal systematic investigation of these individuals is warranted to determine their proper taxonomic status.

LITERATURE CITED

- Conaway, C. H., and D. W. Pfitzer. 1952. *Sorex palustris* and *Sorex dispar* from the Great Smoky Mountains National Park. J. Mammal. 33:106-108.
- Doutt, J. K., C. A. Heppenstall, and J. E. Guilday. 1973. Mammals of Pennsylvania. 3rd ed. Pennsylvania Game Commission, Harrisburg.
- Enders, J. E. 1985. *Sorex palustris punctulatus*. Pages 383-385 in Species of Special Concern in Pennsylvania. H. H. Genoways and F. J. Brenner, editors. Carnegie Mus. Nat. Hist., Spec. Publ. 11.
- Feldhamer, G. A., J. E. Gates, and J. A. Chapman. 1984. Rare, threatened, endangered and extirpated mammals from Maryland. Pages 395-438 in Threatened and Endangered Plants and Animals of Maryland, A. W. Norden, D. C. Forester, and G. H. Fenwick, editors. Maryland Nat. Herit. Prog., Spec. Publ. 84-1.
- Handley, C. O., Jr. 1980. *Sorex palustris punctulatus*. Pages 490-491 in Endangered and Threatened Plants and Animals of Virginia, D. W. Linzey, editor. Center for Environmental Studies, Va. Polytech. Inst. and State Univ., Blacksburg.
- Hooper, E. L. 1942. The Water Shrew (*Sorex palustris*) of the southern Allegheny Mountains. Occas. Pap. Mus. Zool., Univ. Michigan 463:1-4.
- Lee, D. S., and J. B. Funderburg. 1977. Mammals. Pages 385-408 in Endangered and Threatened Plants and Animals of North Carolina, J. E. Cooper, S. S. Robinson, and J. B. Funderburg, editors. N.C. State Mus. Nat. Hist., Raleigh.
- Linzey, D. W. 1983. Status and distribution of the northern Water Shrew (*Sorex palustris*) and two subspecies of Northern Flying Squirrel (*Glaucomys sabrinus coloratus* and *Glaucomys sabrinus fuscus*). Final report under U.S. Fish and Wildl. Ser., Contract No. 14-16-005-79-068.
- Linzey, D. W., and A. V. Linzey. 1971. Mammals of Great Smoky Mountains National Park. Univ. Tennessee Press, Knoxville.
- Linzey, D. W., and A. V. Linzey. 1973. Notes on food of small mammals from Great Smoky Mountains National Park, Tennessee-North Carolina. J. Elisha Mitchell Sci. Soc. 89:6-14.
- Pagels, J. F., and C. M. Tate. 1976. Shrews (Insectivora: Soricidae) of the Paddy Knob-Little Back Creek area of western Virginia. Virginia J. Sci. 27:202-203.
- Smith, E. R., J. B. Funderburg, Jr., and T. L. Quay. 1960. A Checklist of North Carolina Mammals. N.C. Wildl. Res. Comm., Raleigh.
- Whitaker, J. O., Jr., G. S. Jones, and D. D. Pascal, Jr. 1975. Notes on mammals of the Fires Creek area, Nantahala Mountains, North Carolina, including their ectoparasites. J. Elisha Mitchell Sci. Soc. 91:13-17.

Prepared by Wm. DAVID WEBSTER

ROCK SHREW

(BIG-TAILED SHREW, LONG-TAILED SHREW)

Description. The Rock Shrew most closely resembles the Smoky Shrew; both are intermediate in size between the Water Shrew, which is larger, and the Masked, Pygmy, and Southeastern shrews, which are smaller (Fig. 20). Compared to the Smoky Shrew, the Rock Shrew has a longer and thicker tail (four-fifths the head and body length versus two-thirds), relatively flat facial profile, more slender body, and less tooth pigmentation. The fur of *Sorex dispar* is grayish above throughout the year, never brownish as in summer-taken Smoky Shrews, and paler on the venter, especially the feet and ankles. The tail is slightly darker above than below. The dental formula is $3/1, 1/1, 3/1, 3/3 = 32$. Compared to *S. d. dispar*, *S. d. blitchi* averages darker in color and larger in external and cranial dimensions. Selected external measurements (in mm), with means in parentheses, of six male and five female *S. d. blitchi* from southwestern North Carolina and southeastern Tennessee are: total length, 123-135 (130.7); length of tail, 62-66 (64.0); and length of hind foot, 15-16 (15.5) (Schwartz 1956). Six specimens from the Great Smoky Mountains National Park (GSMNP) weighed between 3.8 and 5.4 grams, averaging 4.7 grams (Conaway and Pfitzer 1952).

Range. The Rock Shrew is found in the Appalachian Mountains from North Carolina and Tennessee northward to northern Maine (Fig. 22). In North Carolina the Rock Shrew has been reported from Avery, Buncombe, Haywood, Jackson, Swain, and Yancey counties (Clark, pers. comm.; Conaway and Pfitzer 1952; Schwartz 1956; Smith 1985). The holotype of *Sorex dispar blitchi* came from a place 2 miles (3.2 km) NE of Wagon Road Gap at 4525 feet (1380 m) in Haywood County, N.C.

Habitat. *Sorex dispar* is probably the most stenotopic mammal in eastern North America, where it is a denizen of moist talus slopes, damp rocky outcrops, and the deepest recesses of boulder-strewn slopes in both evergreen and hardwood forests. Most specimens have come from talus of considerable depth, either natural or that associated with highway roadcuts. North Carolina records are from elevations above 1345 m.

Life History and Ecology. There is a dearth of information about the Rock Shrew in North Carolina. Rock Shrews in GSMNP are in long winter pelage between 16 October and 27 April, whereas an individual taken on 2 October was in short summer pelage and another taken on 25 April was molting (Schwartz 1956). Specimens from Virginia replace their winter fur between May and early July; summer pelage is replaced in September (Handley 1980). Individuals in GSMNP

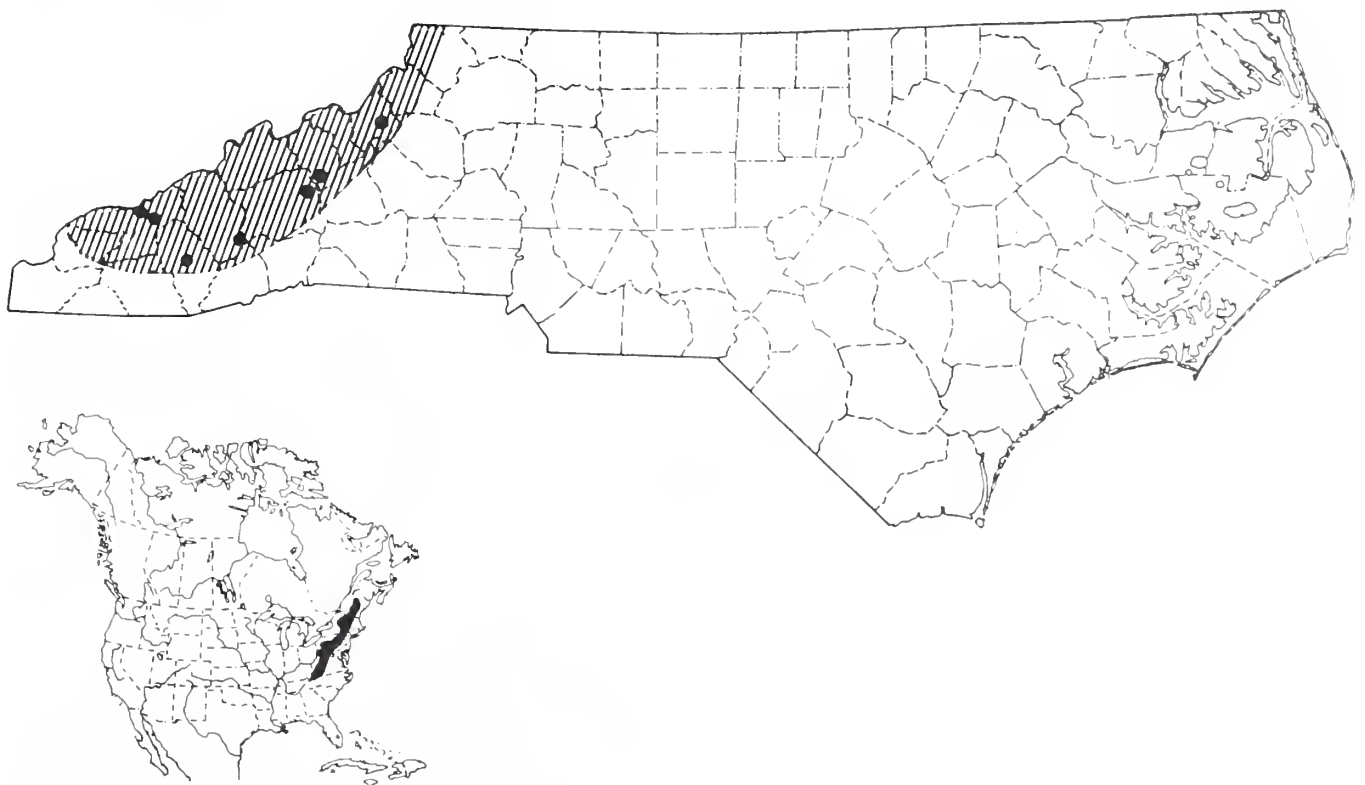


Fig. 22. The known distribution of *Sorex dispar* in North Carolina. Total range of the species is indicated on the insert of North America

eat beetles and spiders (Conaway and Pfitzer 1952).

Status. Undetermined.

Rationale for Evaluation. Because of its limited geographic distribution, its habitat specificity, and the paucity of local natural history information, the Rock Shrew is included in the Undetermined category in North Carolina. It has been listed similarly in Maryland (Feldhamer et al. 1984) and as Special Concern in Virginia (Handley 1980).

ACKNOWLEDGMENTS.— I thank Mary Kay Clark, who provided an unpublished record of *S. dispar* from Grandfather Mountain in Avery County; David A. Adams, who provided an unpublished record from Mount Mitchell, Yancy County; and Harry E. LeGrand, Jr., for reference to Smith's (1985) manuscript.

LITERATURE CITED

- Conaway, C. H., and D. W. Pfitzer. 1952. *Sorex palustris* and *Sorex dispar* from the Great Smoky Mountains National Park. J. Mammal. 33:106-108.
- Feldhamer, G. A., J. E. Gates, and J. A. Chapman. 1984. Rare, threatened, endangered and extirpated mammals from Maryland. Pages 395-438 in Threatened and Endangered Plants and Animals of Maryland. A. W. Norden, D. S. Forester, and G. H. Fenwick, editors. Maryland Nat. Herit. Prog., Spec. Publ. 84-1.
- Handley, C. O., Jr. 1980. *Sorex dispar dispar*. Pages 541-544 in Endangered and Threatened Plants and Animals of Virginia, D. W. Linzey, editor. Center for Environmental Studies, Va. Polytech. Inst. and State Univ., Blacksburg.
- Schwartz, A. 1956. A new subspecies of the longtail shrew (*Sorex dispar* Batchelder) from the southern Appalachian Mountains. J. Elisha Mitchell Sci. Soc. 72:24-30.
- Smith, A. B. 1985. Natural areas survey of Buncombe County. Unpubl. report to N.C. Nat. Herit. Prog.

Prepared by WM. DAVID WEBSTER

Sorex hoyi winnemana Preble PREBLE'S PYGMY SHREW

Description. The Pygmy Shrew is the smallest mammal in North America. Nonetheless, it can be confused with two other small soricids (Fig. 20), the Masked and Southeastern shrews, whose ranges are more or less parapatric in the Mid-Atlantic States and overlap that of the Pygmy Shrew. The Pygmy Shrew can be best distinguished from other species of long-tailed shrews (genus *Sorex*) by looking at the upper teeth. In *S. hoyi* the third and fifth unicuspid are greatly reduced in size and, therefore, only three unicuspid are visible in lateral view, whereas in other North American members of the genus the third and fifth unicuspid are of sufficient size that five unicuspid typically are obvious in lateral view. The dorsal pelage of *S. hoyi* is

reddish-brown in summer and grayish-brown in winter; fur on the venter and feet is much paler. The tail is distinctly bicolored, dark above and pale below. The dental formula is 3/1, 1/1, 3/1, 3/3 = 32. Specimens assignable to *S. h. winnemana* average smaller than those from other areas in the range of the species. Selected external measurements (in mm), with means in parentheses, of four specimens from Maryland (2) and North Carolina (2) are: total length, 75-86 (81); length of tail, 28-33 (30); and length of hind foot, 9-10 (10) (Handley et al. 1980). Two *S. h. winnemana* weighed 1.5 and 2.3 g (Diersing 1980).

Range. *Sorex hoyi* is known from the northern coniferous forests of Alaska, Canada, Washington, Montana, the Great Lakes region, and much of New England. There is a disjunct population in the Rocky Mountains of Wyoming and Colorado as well as an apparently isolated population in the southern Appalachians (Maryland southward to northern Georgia and westward to southeastern Illinois). In North Carolina, there are two specimens from Bent Creek Experimental Forest in Pisgah National Forest in Buncombe County (Jackson 1928) and one individual from Newfound Gap in Swain County (Hoffmeister 1968) (Fig. 23). The two shrews from Bent Creek, a locality ambiguously referred to as "the Pisgah Forest" by Hamilton (1943:50), apparently has been confused with the town of Pisgah Forest in Transylvania County by Diersing (1980), Smith et al. (1960), and Lee et al. (1982).

Habitat. Handley et al. (1980) compiled what is known about the Pygmy Shrew in the southern Appalachians. Most specimens have come from relatively well-drained ridges and slopes in forests dominated by Red Maple (*Acer rubrum*), Yellow Birch (*Betula lutea*), and Tulip Poplar (*Liriodendron tulipifera*); individuals have been taken in or around rotting logs and stumps, in pitfall traps, or under fortuitous circumstances, usually from habitats with deep leaf litter or a scant amount of underbrush, and seldom from sites adjacent to permanent sources of water.

Life History and Ecology. Nothing is known about the Pygmy Shrew in North Carolina, save the anecdotal comments by Jackson (1928) and Hoffmeister (1968). Based on information provided from specimens taken elsewhere in its range, *S. hoyi winnemana* usually nests in rotting logs and stumps, and forages under leaf litter for invertebrates. Preble (1910) examined one Pygmy Shrew from Virginia in short summer pelage on 25 April and another from Maryland in long winter pelage on 24 January.

Status. Undetermined.

Rationale for Evaluation. Owing to its apparent scarcity in the state, the Pygmy Shrew is listed as Undetermined in North Carolina. It is afforded a similar listing in Pennsylvania (Genoways 1985), and is considered Rare in Maryland (Feldhamer et al. 1984) and of Special Concern in Virginia (Handley et al. 1980).

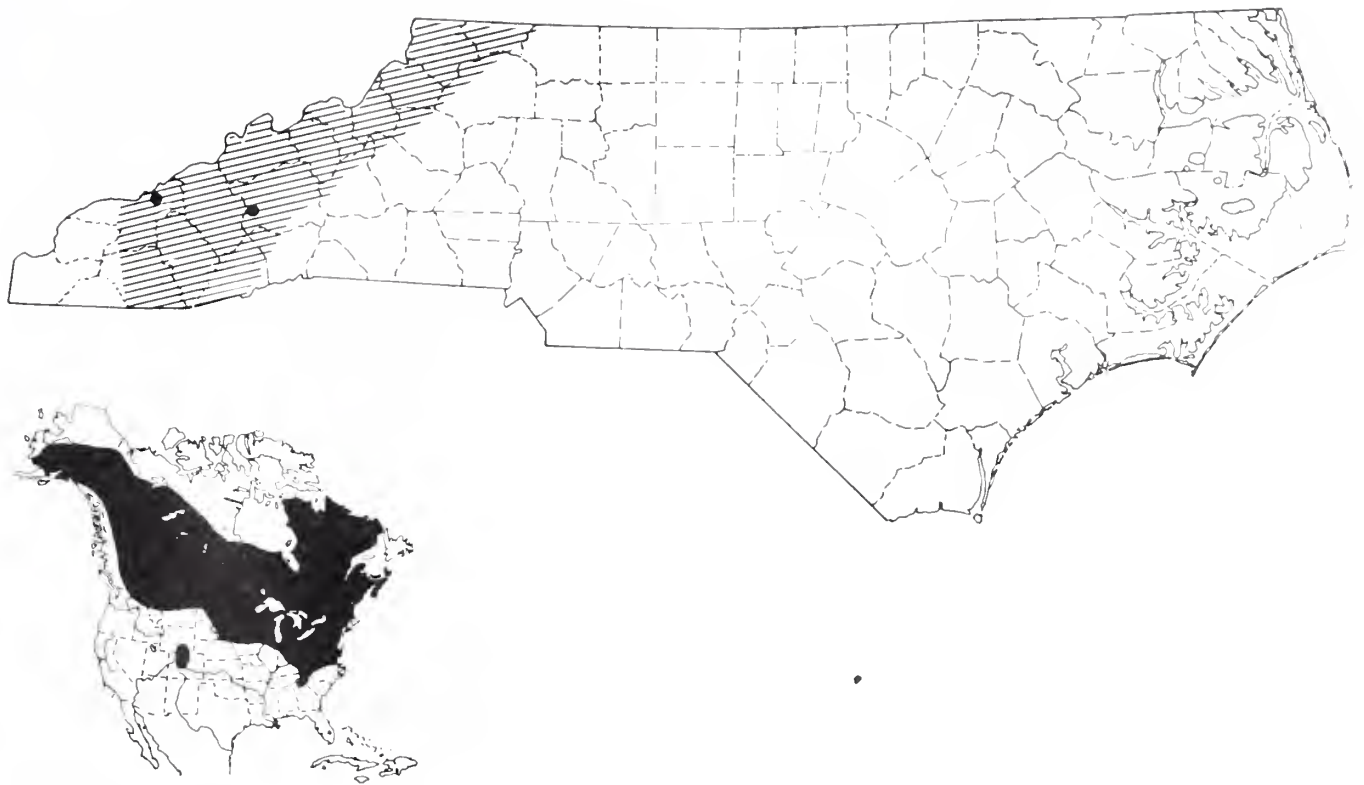


Fig. 23. The known and expected distribution of *Sorex hoyi* in North Carolina. Total range of the species is indicated on the insert of North America.

The taxonomy of the Pygmy Shrew has been the subject of recent debate. Long (1972) recognized two species, *Microsorex hoyi* and *M. thompsoni*, with *M. thompsoni winnemana* occurring in North Carolina. Van Zyll de Jong (1976) and Diersing (1980) subsequently concluded that Pygmy Shrews consist of one polytypic species. Diersing (1980) also provided a convincing argument for recognizing Pygmy Shrews as a subgenus (*Microsorex*) within the genus *Sorex*, an arrangement that best reflects the evolutionary relationships among members in that genus.

LITERATURE CITED

- Diersing, V. E. 1980. Systematics and evolution of the pygmy shrews (subgenus *Microsorex*) of North America. *J. Mammal.* 61:76-101.
- Feldhamer, G. A., J. E. Gates, and J. A. Chapman. 1984. Rare, threatened, endangered and extirpated mammals from Maryland. Pages 395-438 in *Threatened and Endangered Plants and Animals of Maryland*, A. W. Norden, D. C. Forester, and G. H. Fenwick, editors. Maryland Nat. Herit. Prog., Spec. Publ. 84-1.
- Genoways, H. H. 1985. *Microsorex hoyi*. Pages 386-388 in *Species of Special Concern in Pennsylvania*, H. H. Genoways and F. J. Brenner, editors. Carnegie Mus. Nat. Hist., Spec. Publ. 11.
- Hamilton, W. J., Jr. 1943. *The Mammals of Eastern United States*. Comstock Publ. Co., Ithaca, N.Y.
- Handley, C. O., Jr., J. F. Pagels, and R. H. de Rageot. 1980. *Microsorex hoyi winnemana*. Pages 545-547 in *Endangered and Threatened Plants and Animals of Virginia*, D. W. Linzey, editor. Center for Environmental Studies, Va. Polytech. Inst. and State Univ., Blacksburg.
- Hoffmeister, D. F. 1968. Pygmy Shrew, *Microsorex hoyi winnemana*, in Great Smoky Mountains National Park. *J. Mammal.* 49:331.
- Jackson, H. H. T. 1928. A taxonomic review of the American long-tailed shrews (genera *Sorex* and *Microsorex*). *N. Amer. Fauna* 51:1-238.
- Lee, D. S., J. B. Funderburg, Jr., and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. Occas. Pap. N.C. Biol. Surv.
- Long, C. A. 1972. Taxonomic revision of the mammalian genus *Microsorex* Coues. *Trans. Kansas Acad. Sci.* 74:181-196.
- Preble, E. A. 1910. A new *Microsorex* from the vicinity of Washington, D.C. *Proc. Biol. Soc. Washington* 23:101-102.
- Smith, E. R., J. B. Funderburg, Jr., and T. L. Quay. 1960. A Checklist of North Carolina Mammals. N.C. Wildl. Res. Comm., Raleigh.
- Van Zyll de Jong, C. G. 1976. Are there two species of pygmy shrews (*Microsorex*)? *Canadian Field-Nat.* 90:485-487.

Prepared by WM. DAVID WEBSTER

Description. Like other North American moles, the Star-nosed Mole has numerous adaptations associated with its subterranean lifestyle: the greatly enlarged forefeet and highly modified pectoral girdle increase burrowing efficiency; the dense and velvety blackish underfur and the absence of guard hairs facilitate movement in tunnels; pinnae are vestigial; and the penis is internal. The most diagnostic character of the Star-nosed Mole is the 22 fleshy nasal rays (Fig. 24) that surround the nares and are used as tactile organs. The eyes are small but well developed, and the tail is moderately haired and about one-third the total length of the animal. The dental formula is $3/3, 1/1, 4/4, 3/3 = 44$. There is no secondary sexual dimorphism; however, in both sexes the tail thickens at its base from an accumulation of fat during the breeding season. *Condylura cristata cristata*, which is found much farther to the north, is slightly larger than *C. cristata parva* in external and cranial dimensions. Selected external measurements (in mm), with means in parentheses, of six *C. cristata parva* from Virginia, North Carolina, and South Carolina are: total length, 158-170 (163.8); length of tail, 57-63 (60.3); and length of hind foot, 25-26 (25.2) (Paradiso 1959).

Range. The Star-nosed Mole is distributed throughout much of northeastern North America, and finger-like projections of this range pass southward along the Appalachian Mountains to southwestern North Carolina and along the Atlantic Coastal Plain to southeastern Georgia. Thus there are two distinct populations in North Carolina (Fig. 25).

Habitat. Specimens have been taken in wet montane habitats such as marshes, seeps, and stream banks.

Little is known about the habitat preferences of individuals from the Coastal Plain, but they probably inhabit wetlands also. Label data on a specimen (NCSM 3283) from Richmond County, N.C., read "0.1 mi. S Lumber River," and other coastal records are from such wet environments as the Dismal (Virginia) and Okefenokee (Georgia) swamps.

Life History and Ecology. Star-nosed Moles are active at day and night throughout the year, foraging above ground and in tunnels and water for aquatic and terrestrial annelids and arthropods (Hamilton 1931). Nests are constructed from dead leaves and grasses and are built under logs, stumps, and rocks, but always above high water. Three to seven young are born in April or May after a gestation period of approximately 45 days; the young grow rapidly and are sexually mature in their first year of life (Davis and Peek 1970, Eadie and Hamilton 1956).

Status. Undetermined.

Rational for Evaluation. Star-nosed Moles are relatively abundant in suitable habitat in the mountains of North Carolina, and the natural history of these specimens appears to be similar to that described for individuals from northeastern North America and southeastern Canada. Moles from the eastern part of North Carolina, however, are known from widely scattered localities. There is a dearth of information about most aspects of their biology, and the effects of man's land-use practices, such as ditching and draining, on population dynamics are unknown. The Coastal Plain population of the Star-nosed Mole, therefore, is listed as Undetermined.

Recommendations. Additional pockets of *Condylura* in eastern North Carolina need to be located, and the natural history and ecology of these animals should be investigated.

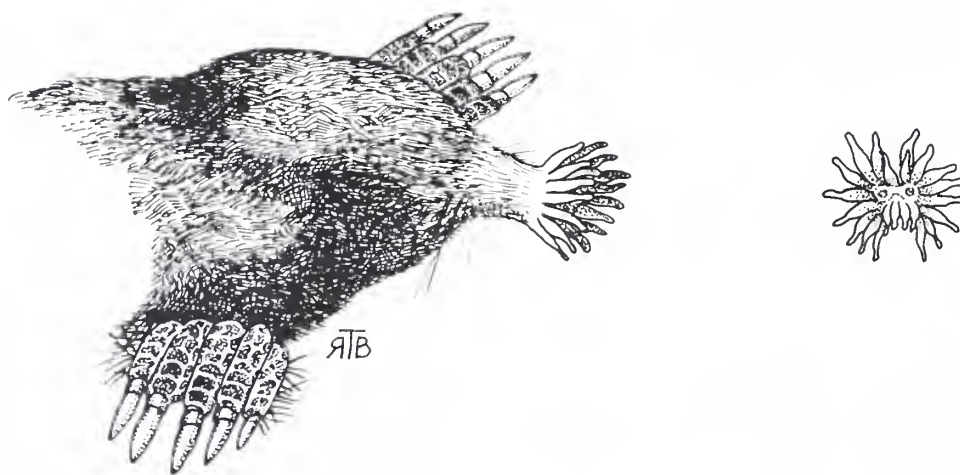


Fig. 24. The nose of *Condylura cristata*, ringed with 22 fleshy appendages, easily distinguishes this species from the other two North Carolina moles.

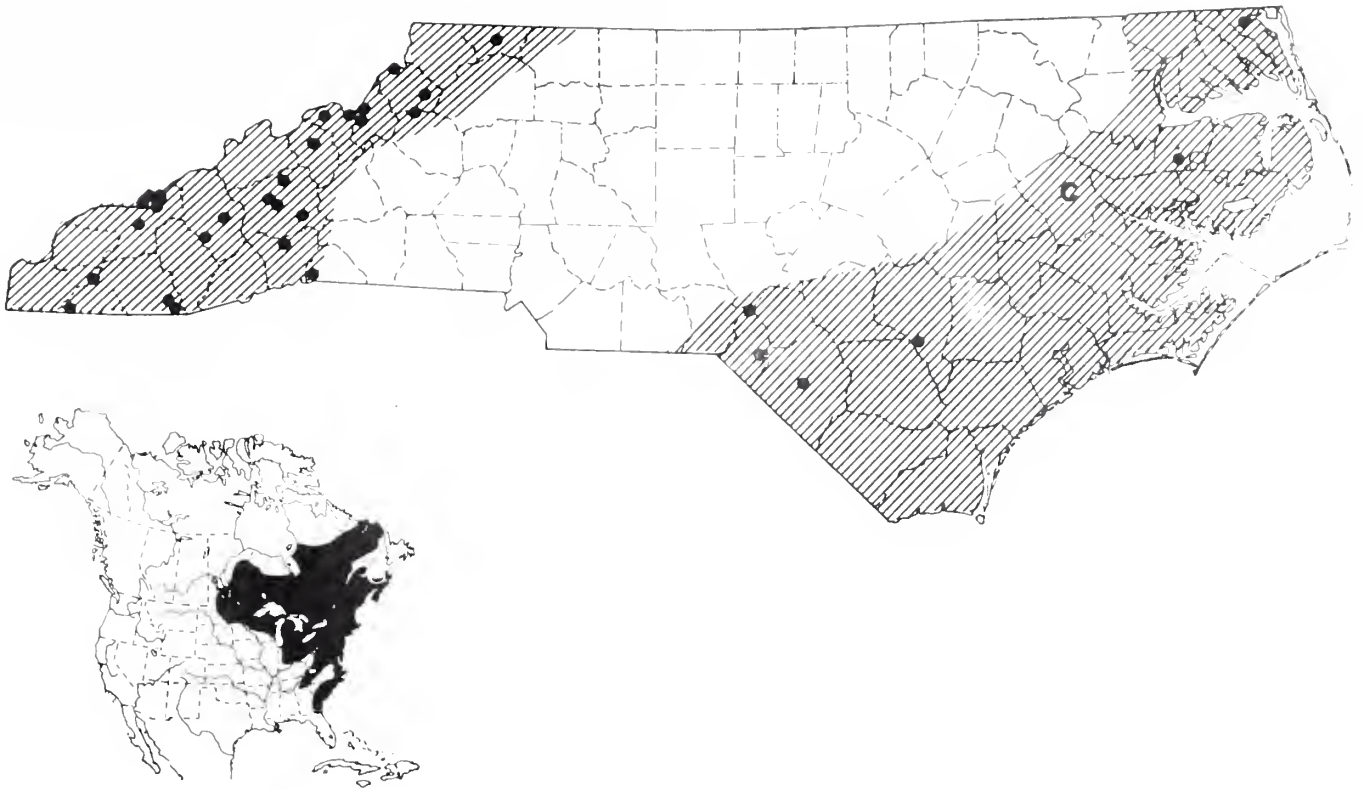


Fig. 25. The known distribution of *Condylura cristata* in North Carolina. Total range of the species is indicated on the insert of North America.

LITERATURE CITED

- Davis, D. E., and F. Peek. 1970. Litter size of the Star-nosed Mole (*Condylura cristata*). J. Mammal. 51:156.
- Eadie, W. R., and W. J. Hamilton, Jr. 1956. Notes on reproduction in the Star-nosed Mole. J. Mammal. 37:223-231.
- Hamilton, W. J., Jr. 1931. Habits of the Star-nosed Mole, *Condylura cristata*. J. Mammal. 12:345-355.
- Paradiso, J. L. 1959. A new Star-nosed Mole (*Condylura*) from the southeastern United States. Proc. Biol. Soc. Washington 72:103-108.

Prepared by WM. DAVID WEBSTER

Sylvilagus transitionalis (Bangs)

NEW ENGLAND COTTONTAIL

Description. *Sylvilagus transitionalis* is a moderate-sized rabbit with mean body length around 349 mm, hind foot 95 mm, and ear length from notch of 55 mm. Ears are generally shorter than those of *S. floridanus*, rounded, and often with black hair covering the anterior edges (Fig. 26). Upper parts are almost uniform pinkish buffy, with the back overlaid with a blackish wash that gives a fine-streaked effect. The top of the head often has a narrow black patch between the ears (Blair et al. 1968). Pelage characteristics are not always adequate to

distinguish between *S. floridanus* and *S. transitionalis*, however. Two pelage characteristics that are helpful are the grizzled cheek region and the absence of a black saddle in *S. transitionalis* (Chapman and Morgan 1973). The two species are readily distinguishable by cranial characteristics, the most prominent identifying feature being the jagged and irregular posterior margins of the nasal bones (Fig. 26) when compared with the smooth pattern seen in *S. floridanus*. Detailed cranial descriptions can be found in Chapman and Morgan (1973), Blair et al. (1968), Golly (1962), and Hamilton (1943).

Range. Generally the range is considered to be the forests of the Atlantic Coast from southern Maine to southern New Jersey, west to eastern New York and central Pennsylvania, and south in the Appalachian chain to northern Alabama (Blair et al. 1968). In 1972, however, the first records of *S. transitionalis* were obtained from Maryland (Chapman and Paradiso 1972). This was, apparently, not a range expansion but, more likely, just a result of better documentation. In fact, the type locality in New London County, Connecticut, no longer has a population (Chapman 1975), indicating an apparent trend common in many New England states. The range of *S. transitionalis* is apparently much more restricted than originally believed. Chapman and Stauffer (1979) proposed the hypothesis that the New England Cottontail is a

refugional relict resulting from a southward retreat during the cooling climate and vegetative changes associated with the Pleistocene glaciation. When the warming trend began and vegetative changes reversed, relict populations were left in islands of suitable habitat at high elevations. The range map (Fig. 27) indicates a clumped distribution. In North Carolina *S. transitionalis* is restricted to the mountains, probably at elevations ranging above 2500 feet (Fig. 27). Populations of *S. transitionalis* in Virginia have been found at elevations between 1880 and 1980 feet (Blymyer 1976); however, the more southern latitude of North Carolina very likely results in a higher elevation limit in this state.

Habitat. *Sylvilagus transitionalis* is an inhabitant of "ivy patches" composed largely of *Kalmia* and *Vaccinium* (Barbour 1951). In the southern Appalachians, *S. transitionalis* reaches its peak abundance in 5- to 10-year-old clearcuts or older scrubby vegetation found along stream bottoms at high elevations. In all locations, conifers and one or more ericaceous (*Kalmia*, *Vaccinium*, or *Rhododendron*) shrubs are present (Chapman and Stauffer 1979). Populations exceeding one per acre in a 7-year-old clearcut have been found

(Blymyer 1976). Small areas of suitable habitat not in association with other areas may not be suitable for long-term survival. In western Maryland *S. transitionalis* does not survive and reproduce in areas of less than 20,000 ha containing suitable habitat (Chapman et al. 1977).

Life History and Ecology. Breeding biology is very similar to that of *S. floridanus*. Mean litter size is 3.56 with synchronous breeding occurring from March through August. The mean number of litters is 6.5 per year. Some young-of-the-year breeding occurs with early-born individuals. All are sexually mature the spring following birth (Chapman et al. 1977). Food habits are also similar to those of *S. floridanus*, but *S. transitionalis* may have a much more restricted diet in the summer (Chapman et al. 1982). *Sylvilagus transitionalis* is much better adapted to cold climates than is *S. floridanus*. The New England Cottontail shows high condition indices in the winter and spring and lowest in the summer. The Eastern Cottontail, however, shows highest condition in the spring and lowest in the winter. This may be important in enabling *S. transitionalis* to resist competition for available habitat with *S. floridanus* (Chapman et al. 1977).

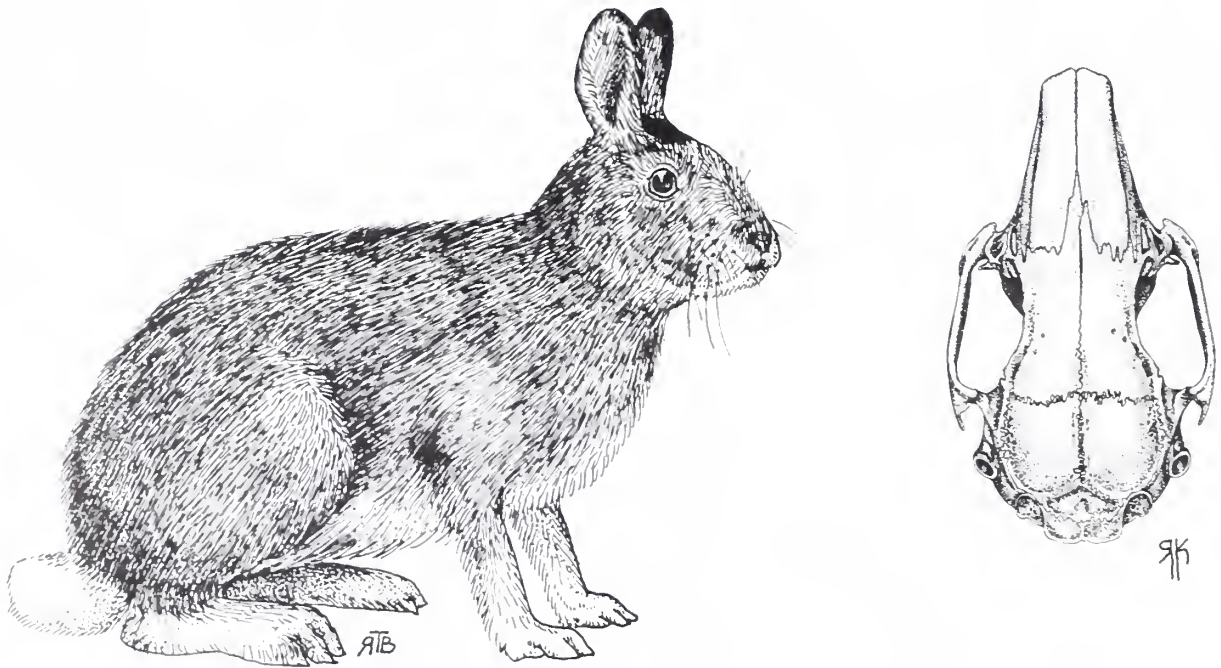


Fig. 26. *Sylvilagus transitionalis* is a moderate-sized rabbit that is often difficult to distinguish by pelage from *S. floridanus*. The most prominent identifying cranial feature is the jagged, irregular posterior margin of the nasal bones. These are smooth in both *S. floridanus* and *S. aquaticus*.

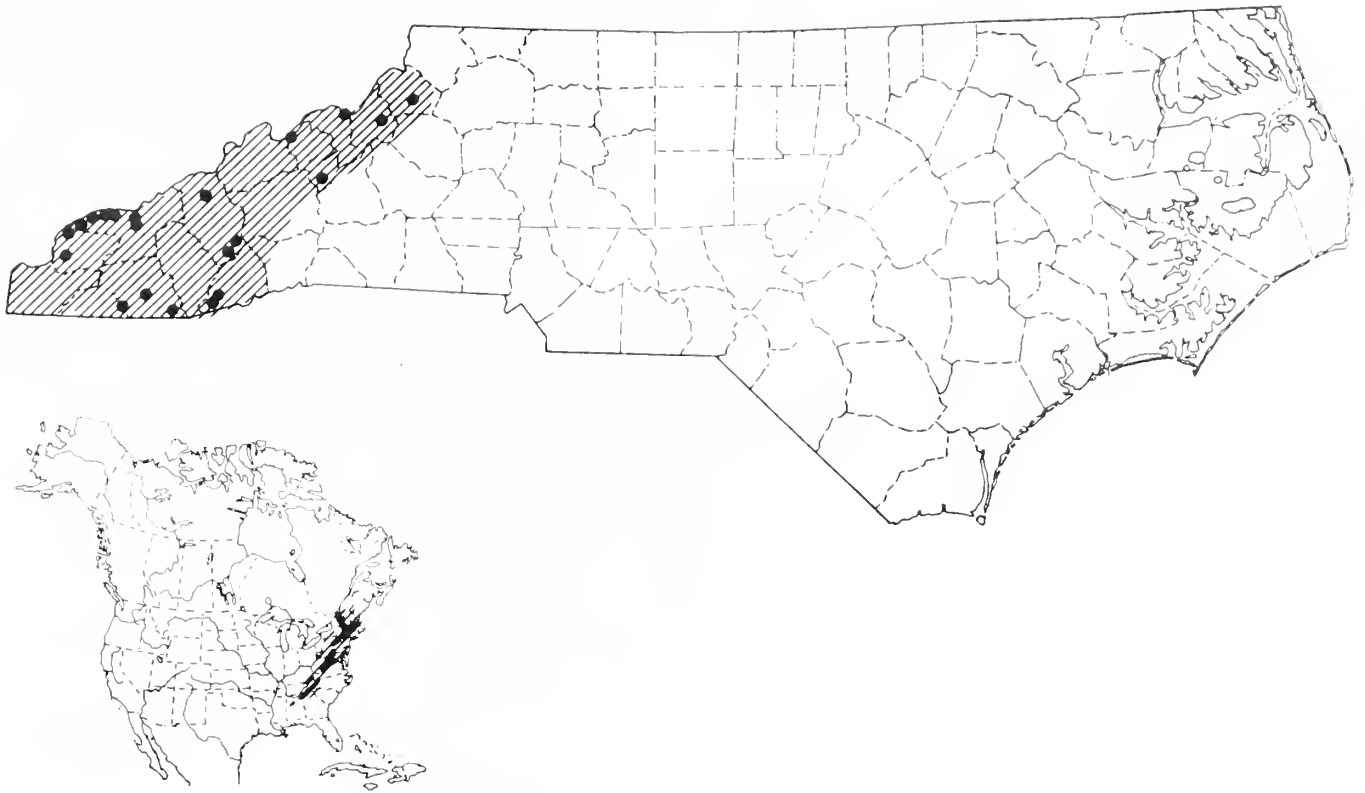


Fig. 27. The known and expected distribution of *Sylvilagus transitionalis* in North Carolina. Total range of the species is indicated on the insert of North America; hatched areas indicate historic range.

Special Significance. Although similar to *S. floridanus* in many ways, *S. transitionalis* is a distinct species much further removed from an evolutionary standpoint than either of the other three extant species of *Sylvilagus* in North Carolina. Karyotypic studies show *S. aquaticus*, *S. floridanus*, and *S. palustris* to have a more recent common ancestry (Robinson et al. 1983, 1984). Other karyotypic studies have found striking additional differences between *S. transitionalis* and *S. floridanus* (Wilson 1979). On the other hand, the lack of intraspecific differences in *S. transitionalis* is remarkable when compared to other members of the genus. As early as 1909, it was noted that specimens from Massachusetts and specimens from Virginia were identical (Nelson 1909). More recently, karyotypic studies show the same lack of intraspecific variation (Wilson 1979). Because some demes have been isolated from main populations since the last glaciation, variations that do exist due to natural selection will be important to study (Chapman and Stauffer 1979). Studies of the amount of intraspecific variation between different sub-populations may be important in better understanding the role of natural selection in the evolutionary process.

Status. Undetermined.

Rationale for Evaluation. The decline of *S. transitionalis* in New England is well documented. The status

of this decline is, however, in question. Whether or not the species is declining toward extinction or recovering from near extinction brought about by early land clearing is unknown. Because of the existence of *S. transitionalis* populations in forests reclaimed from old fields, the latter hypothesis may be the case (Chapman et al. 1977). Present policies of reforestation and preservation of primeval tracts in western North Carolina may have already turned the tide toward recovery. Outlining another threat to its existence, Chapman and Morgan (1973) proposed that an intergradation of *S. floridanus mallurus* with other subspecies had produced an extremely efficient utilizer of "coarse-grained" habitats through what they termed the "niche width-introduction" hypothesis. This new rabbit was feared to be invading traditional *S. transitionalis* habitat and displacing the species. Local hunters and North Carolina Wildlife Resources Commission enforcement personnel (Dan J. Moore, pers. comm.) reported that in the area of Black Balsam Mountain there was, as late as 1980, an extremely high population of rabbits. Many locals referred to them as "small short-eared rabbits." On the basis of this report, an attempt was made, with the aid of Officer Moore, to collect rabbits from this area to document the presence of *S. transitionalis*. At the time of the collection, in October 1983, the population had declined dramatically. More than 200 trap-nights under ideal weather conditions yielded

only two captures. These two specimens and one taken by night-hunting were all *S. floridanus*. Whether or not this is a case of displacement of *S. transitionalis* by *S. floridanus* is unknown. Introductions of rabbits ranging from Midwestern subspecies to New Zealand Whites are reported by local hunters in the area. This is certainly a situation that deserves further study.

Current Protection. Much of the habitat available for *S. transitionalis* is currently in federal ownership. Preservation of naturally occurring ericaceous tracts on Park Service and National Forest land and forestry practices on National Forest land that maintain a number of small clearcuts in the 5- to 10-year range are already benefiting the species. Rabbits are not separated by species under North Carolina hunting regulations; therefore, the New England Cottontail may be hunted legally. Rabbit hunting, however, is not a strong tradition in many areas inhabited by *S. transitionalis*.

Recommendations. Chapman and Stauffer (1979) recommended that *S. transitionalis* be listed as a species of "special concern." Chapman and Fuller (1975) stated that the species deserves continuous close monitoring, and they suggested that protected refuge areas could forestall eventual extermination. Additional protection afforded by closing the hunting season on this species would be difficult because of the problems of species identification from external characteristics. Fortunately, such action is not warranted at this time. Much more attention should be given to managing public land for *S. transitionalis*, however. Maintenance of heath balds by fire is currently being used to a limited extent by the National Forest Service, but use of this practice should be increased. Habitat needs of *S. transitionalis* should become an important part of future Forest Service planning considerations to ensure that cutting schedules will benefit the species. Documentation is needed of current range and status of existing populations to form a base-line for any future studies on possible declines resulting from increased competition from *S. floridanus*. Stronger regulations on importation of wildlife are needed along with a public education program on the dangers of non-native introductions.

LITERATURE CITED

- Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cage, and G. A. Moore. 1968. *Vertebrates of the United States*. 2nd ed. McGraw-Hill Book Co., New York.
- Blymyer, M. J. 1976. A new elevation record for the New England Cottontail in Virginia. *Chesapeake Sci.* 17: 220-221.
- Barbour, R. W. 1951. The mammals of Big Black Mountain, Harlan County, Kentucky. *J. Mammal.* 32:100-110.
- Chapman, J. A. 1975. *Sylvilagus transitionalis*. Mammalian Species No. 55. Amer. Soc. Mammal.
- , and K. B. Fuller. 1975. Our changing cottontails. *Atlantic Nat.* 30:54-59.
- , A. L. Harmon, and D. E. Samuel. 1977. Reproductive and physiological cycles in the cottontail complex in western Maryland and nearby West Virginia. *Wildl. Monogr.* 56:1-73.

- , J. G. Hockman, and W. R. Edwards. 1982. Cottontails (*Sylvilagus floridanus* and allies). Pages 83-123 in *Wild Mammals of North America: Biology, Management and Economics*, J. A. Chapman and G. A. Feldhamer, editors. The Johns Hopkins Univ. Press, Baltimore, Md.
- , and R. P. Morgan II. 1973. Systematic status of the cottontail complex in western Maryland and nearby West Virginia. *Wildl. Monogr.* 36:1-54.
- , and J. L. Paradiso. 1972. First records of the New England Cottontail (*Sylvilagus transitionalis*) from Maryland. *Chesapeake Sci.* 13:148-149.
- , and J. R. Stauffer, Jr. 1979. The status and distribution of the New England Cottontail, *Sylvilagus transitionalis* (Bangs). Pages 973-983 in *Proc. World Lagomorph Conf.*, Guelph, Ontario, K. Myers and C. D. MacInnis, editors.
- Golly, F. B. 1962. *Mammals of Georgia, a Study of Their Distribution and Functional Role in the Ecosystem*. Univ. Georgia Press.
- Hamilton, W. J. 1943. *The Mammals of the Eastern United States*. Hafner Publ. Co., New York.
- Nelson, E. W. 1909. The rabbits of North America. *N. Amer. Fauna* 29:1-314.
- Robinson, T. J., F. F. B. Elder, and J. A. Chapman. 1983. Evolution of chromosomal variation in cottontails, genus *Sylvilagus* (Mammalia: Lagomorpha): *S. aquaticus*, *S. floridanus*, and *S. transitionalis*. *Cytogenet. Cell Genet.* 35:216-222.
- . 1984. Evolution of chromosomal variation in cottontails, genus *Sylvilagus* (Mammalia: Lagomorpha): *S. audubonii*, *S. idahoensis*, *S. nuttalli*, and *S. palustris*. *Cytogenet. Cell Genet.* 38:282-289.
- Wilson, J. W. 1979. Systematic status of the two cottontail rabbit species in five New England states, USA. Pages 99-101 in *Proc. World Lagomorph Conf.*, Guelph, Ontario, K. Myers and C. D. MacInnis, editors.

Prepared by CARL W. BETSILL

Sylvilagus aquaticus (Bachman) SWAMP RABBIT

Description. This rabbit (Fig. 28) is the largest member of the genus. Approximate measurements are: length 465-468 mm, hind foot 105-110 mm, tail 67-71 mm, and ear from notch 68-72 mm. Upper parts are blackish brown or reddish brown, and underparts are white; underside of the tail is white (Blair et al. 1968).

Range. The Swamp Rabbit ranges from eastern Texas and Oklahoma and southern Kansas east to northwestern South Carolina, north in Mississippi embayment to southern Illinois and Indiana. Its range meets but does not overlap that of *S. palustris* in south Georgia and Alabama (Blair et al. 1968). The range of *S. aquaticus* has begun to contract southward in recent years due to drainage and habitat alteration (Chapman et al. 1982). Only one documented specimen (NCSM 843) has been taken from North Carolina. It was collected on 18 August 1956, 11 miles east of Hayesville, Clay County, N.C. (Lee et al. 1982; Fig. 29).

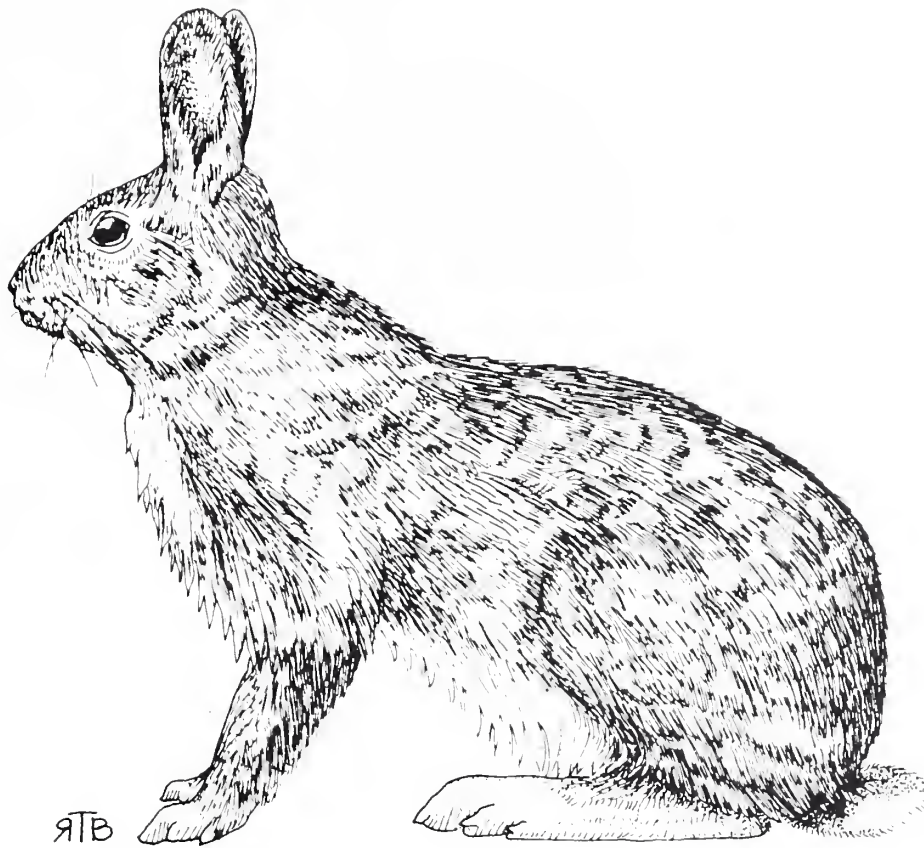


Fig. 28. The Swamp Rabbit, *Sylvilagus aquaticus*, has white underparts and is the largest member of this genus.

Habitat. An inhabitant of flood plains of rivers and creeks, the Swamp Rabbit is seldom found far from this habitat type. Water is generally included within its home range. Resting places are usually on stumps or low crotches of trees and in cane patches (Golly 1962). The species frequently uses standing hollow trees for escape cover. Some dispute exists concerning home range overlap with *S. floridanus*. Low (1958) indicated little overlap in Eastern Cottontail and Swamp Rabbit home ranges, but Toll et al. (1960) indicated a considerable amount. The amount of this overlap may depend a great deal on the width of the particular flood plain in question.

Life History and Ecology. Gestation period is 39 to 40 days with an average litter size of 2.6 (Golly 1962). Synchronous reproductive behavior is shown with evidence of establishment of small breeding units controlled by dominant males (Marsden and Holler 1964). Adrenal stress brought about by severe and long-term flooding has been shown to induce total litter resorption (Conaway et al. 1960). Food habits include emergent aquatic vegetation and succulent herbaceous vegetation such as grasses, sedges, and cane (Golly 1962). *Sylvilagus aquaticus* readily takes to water and will lie submerged with only eyes and nose out of water to escape detection by dogs (Terrel 1972). Behavioral differences between *S. aquaticus* and *S. flo-*

ridanus are described in detail in Marsden and Holler (1964). This study indicates that *S. aquaticus* is much more vocal than other rabbits and displays territoriality not shown in cottontails. A particular behavior that has resulted in a useful census technique is the habit *S. aquaticus* has of depositing pellets on elevated objects such as logs or stumps. Percent of logs used has been used to index over-winter mortality (Terrel 1972).

Special Significance. Populations of *S. aquaticus*, if they still exist in North Carolina, are on the northeastern fringe of the range. Flood plains in this part of the state are narrow and provide the only areas suitable for agriculture and development in many counties. If populations of *S. aquaticus* were ever more widespread in these western counties, they were most likely extirpated early in the settlement of this region. Remaining populations may well be only remnants of populations once inhabiting many of the flood plains in southwestern North Carolina. Latitudinal size differences conforming to Bergman's rule are documented, indicating that the species may have existed in northern ranges longer than historical records indicate (Terrel 1972). Differences between North Carolina specimens, if they exist, and those taken from the traditional range may indicate important adaptations to the mountainous area.

Status. Undetermined.

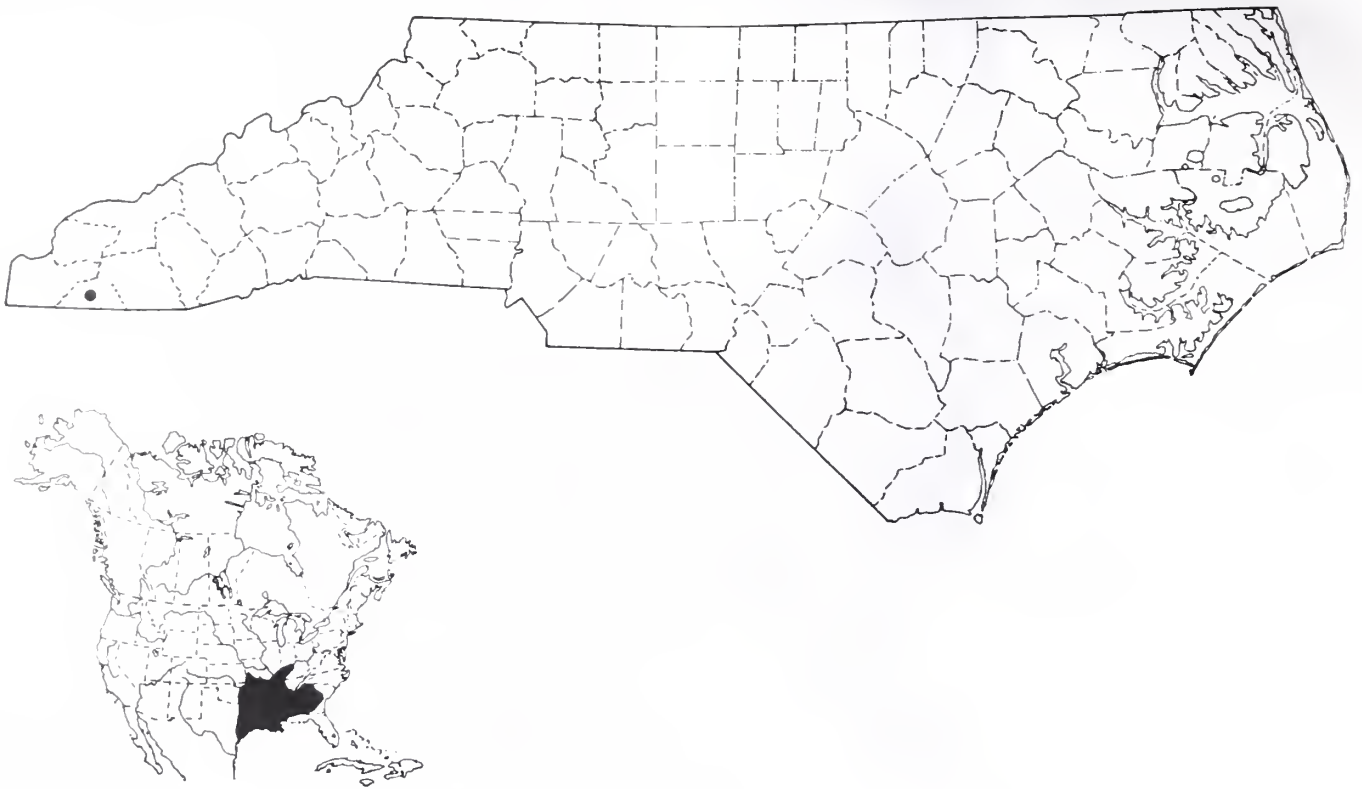


Fig. 29. The known distribution of *Sylvilagus aquaticus* in North Carolina. Total range of the species is indicated on the insert of North America.

Rational for Evaluation. The status of this animal in North Carolina is clearly unknown. Because the only specimen was collected 30 years ago, there is certainly a need to establish whether or not a population still exists in our state.

Current Protection. Rabbits are not separated by species under North Carolina hunting regulations; therefore, no protection from hunting is offered. Development and agriculture along existing flood plains is common in the mountains and has probably adversely affected any populations that existed.

Recommendations. *Sylvilagus aquaticus* sign is readily apparent to the trained observer, and the amount of suitable habitat in the area where the specimen was collected is limited. A couple of days of field investigation should indicate whether or not a population exists in Clay County and vicinity. After this is determined, further plans can be made.

LITERATURE CITED

- Blair, W. F., A. P. Blair, P. Brodkorb, F. R. Cagle, and G. A. Moore. 1968. Vertebrates of the United States. 2nd ed. McGraw-Hill Book Co., New York.
- Chapman, J. A., J. G. Hockman, and W. R. Edwards. 1982. Cottontails (*Sylvilagus floridanus* and allies). Pages 83-123 in Wild Mammals of North America: Biology, Management and Economics, J. A. Chapman and G. A. Feldhamer, editors. The Johns Hopkins Univ. Press, Baltimore, Md.

- Conaway, C. H., T. S. Baskett, and J. E. Toll. 1960. Embryo resorption in the Swamp Rabbit. *J. Wildl. Manage.* 24:197-202.
- Golly, F. B. 1962. Mammals of Georgia, a Study of Their Distribution and Functional Role in the Ecosystem. Univ. Georgia Press, Athens.
- Lee, D. S., J. B. Funderburg, Jr., and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. *Occas. Pap. N.C. Biol. Surv.*
- Low, C. E. 1958. Ecology of the Swamp Rabbit in Georgia. *J. Mammal.* 39:116-127.
- Marsden, H. M., and N. R. Holler. 1964. Social Behavior in Confined Populations of the Cottontail and the Swamp Rabbit. *Wildl. Monogr.* 13:1-39.
- Terrel, T. L. 1972. The Swamp Rabbit (*Sylvilagus aquaticus*) in Indiana. *Amer. Midl. Nat.* 87:283-295.
- Toll, J. E., T. S. Baskett, and C. H. Conaway. 1960. Home range, reproduction, and foods of the Swamp Rabbit in Missouri. *Amer. Midl. Nat.* 63:398-412.

Prepared by CARL W. BETSILL

Microtus chrotorrhinus carolinensis Komarek ROCK VOLE

Description. A medium-sized, grayish-brown vole. *Microtus chrotorrhinus carolinensis* has a "rich yellow" (Burt and Grossenheider 1952:131) or "deep orange rufous" (Hamilton 1943:329) nose that distinguishes it from all other voles (Fig. 30), but this coloration may

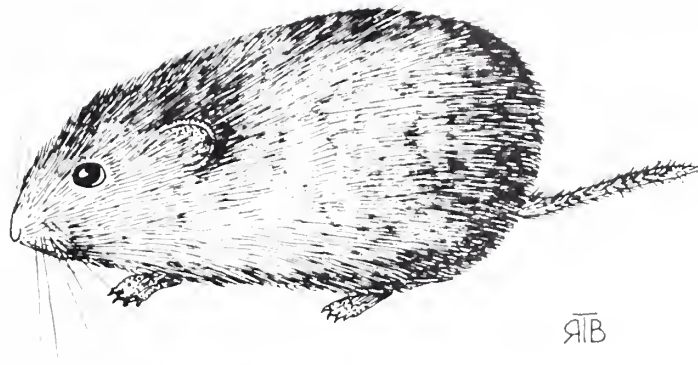


Fig. 30. The Rock Vole, *Microtus chrotorrhinus*, is similar in size and shape to other voles, but may be distinguished from them by the yellowish-orange snout and yellow-brown dorsal pelage, which are sometimes present.

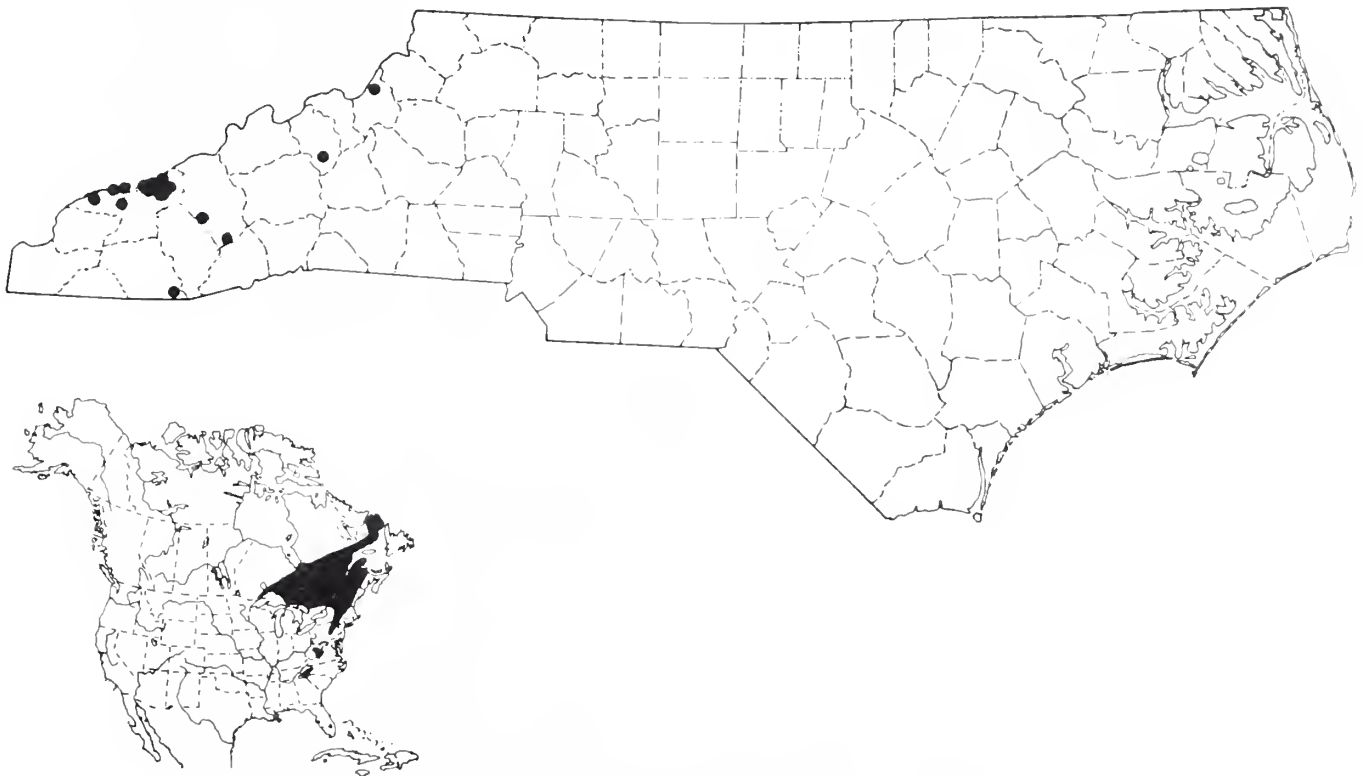


Fig. 31. The known distribution of *Microtus chrotorrhinus* in North Carolina. Total range of the species is indicated on the insert of North America.

be inconspicuous or absent in some individuals (Linzey and Linzey 1971:44). Measurements are: total length 137-170 mm, tail 45-50 mm, and hind foot 19.4-22.0 mm (Hall 1981:811).

Range. Found through the higher Appalachians from Randolph and Pendleton counties, West Virginia (McKeever 1951:99) southward to Swain County, North Carolina, and Sevier County, Tennessee (Hamilton 1943:329), the Rock Vole may be fairly common above 840 m (2,800 feet) in the Great Smoky Mountains

National Park, where the Komareks took 37 specimens (Komarek and Komarek 1938, *in* Hamilton 1943:330). In other parts of North Carolina the Rock Vole is rare or absent (Cooper et al. 1977:406). It is known from the type locality in Swain County, about 9 km (5 miles) north of Smokemont; from Newfound Gap and Mount Kephart in Swain County (Brimley 1945); and from Haywood, Yancey, Avery, and Macon counties (Lee et al. 1982:49). The Rock Vole is probably sympatric with the Red-backed Vole (*Clethrionomys gapperi carolinensis*).

Habitat. Generally found under mesic conditions in and around moss-covered rock outcrops and boulder fields in northern, cove hardwood, or Red Spruce-hardwood forests (McKeever 1951:98). *M. c. carolinensis* may frequent three other types of habitat—rocky talus slopes without grasses, open grassy areas, and birch-beech forests (Linzey and Linzey 1971:44). Herbaceous vegetation is frequently found in burrow entrances and under overhanging rocks. The race is occasionally taken in grass balds (Komarek and Komarek 1938, in Hamilton 1943:330).

Life History and Ecology. Young are born from early spring to late fall (Hamilton 1943:330). A lactating female was taken in West Virginia on 7 September (McKeever 1951:99). Immature individuals were taken in the Great Smoky Mountains National Park in July, August, September, and October (Linzey and Linzey 1971:45). Rock Voles feed mostly on green plants—bunchberry, thread moss, grasses, blueberry—but consume some caterpillars and fungi (Whitaker 1980:501).

Special Significance. This race is limited to the higher southern Appalachians, where it lives in colonies in rock-strewn forests.

Status. Undetermined.

Rationale for Evaluation. Specialized habits and limited, specialized habitat have impeded study of *M. c. carolinensis*, which is poorly represented in collections.

Current Protection. Populations within the Great Smoky Mountains National Park are protected from collecting and habitat alteration. Those on National Forest land may be affected by timbering, and those on

private land may be subjected to habitat changes resulting from timbering and land development.

Recommendations. Additional survey work is needed to determine the distribution and abundance of the Rock Vole in North Carolina.

LITERATURE CITED

- Brimley, C. S. 1945. The mammals of North Carolina. Carolina Tips, Installment 13. August 1945.
- Burt, W. H., and R. P. Grossenheider. 1952. A Field Guide to the Mammals. Riverside Press, Cambridge Mass.
- Cooper, J. E., S. S. Robinson, and J. B. Funderburg. 1977. Endangered and Threatened Plants and Animals of North Carolina. N.C. State Mus. Nat. Hist., Raleigh.
- Hall, E. R. 1981. The Mammals of North America. 2 vol. John Wiley and Sons, New York.
- Hamilton, W. J., Jr. 1943. The Mammals of Eastern United States. Comstock Publishing Co., Inc., Ithaca, N.Y.
- Komarek, E. V., and R. Komarek. 1938. Mammals of the Great Smoky Mountains. Bull. Chicago Acad. Sci. 5(6):137-162.
- Lee, D. S., J. B. Funderburg, Jr., and M. K. Clark. 1982. A Distributional Survey of North Carolina Mammals. Occas. Pap. N.C. Biol. Surv., N.C. State Mus. Nat. Hist., Raleigh.
- Linzey, A. V., and D. W. Linzey. 1971. Mammals of Great Smoky Mountains National Park, Univ. Tennessee Press, Knoxville.
- McKeever, S. 1951. A Survey of West Virginia Mammals. Final report, Pittman-Robertson Project 22-R. Conserv. Comm. W.Va., Charleston.
- Whitaker, J. O., Jr. 1980. The Audubon Society Field Guide to North American Mammals. Alfred A. Knopf, New York.

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AND THE NORTH CAROLINA STATE MUSEUM—1985**

- Lee, David S., and Brooks M. Burr. Observations on life history of the dollar sunfish, *Lepomis marginatus* (Hollbrook). (Abstract). ASB Bulletin 32(2):58. 1985- 1
- Lee, David S., and Mary Kay Clark. Summer food, molt, weights, mercury loads and activity patterns of American Swallow-tailed Kites. (Abstract). Joint Wilson/Cooper Ornithological Societies Meeting. 1985- 2
- Lee, David S., Dan Audet, and Bryant Tarr. Summer bird fauna of North Carolina's Grandfather Mountain. Chat 49:1-14. 1985- 3
- Cooper, John E., and Ray E. Ashton Jr. The *Necturus lewisi* study: introduction, selected literature review, and comments on the hydrologic units and their faunas. Brimleyana 10:1-12. 1985- 4
- Braswell, Alvin L., and Ray E. Ashton Jr. Distribution, ecology, and feeding habits of *Necturus lewisi* (Brimley). Brimleyana 10:13-35. 1985- 5
- Ashton, Ray E., Jr. Field and laboratory observations on microhabitat selection, movements, and home range of *Necturus lewisi* (Brimley). Brimleyana 10:83-106. 1985- 6
- Hall, Russell J., Ray E. Ashton Jr., and Richard M. Prouty. Pesticide and PCB residues in the Neuse River Waterdog, *Necturus lewisi*. Brimleyana 10:107-109. 1985- 7
- Clark, Mary K., David S. Lee, and John B. Funderburg. The mammal fauna of Carolina bays, pocosins, and associated communities in North Carolina. Brimleyana 11:1-38. 1985- 8
- Grant, Gilbert S. Rete mirabilis ophthalmicum and intercarotid anastomosis in Procellariiformes taken off the North Carolina coast. Brimleyana 11:81-86. 1985- 9
- Braswell, Alvin L. *Ambystoma talpoideum*: geographic distribution. SSAR Herp Review 16(1):31. 1985-10
- Murdock, Nora A., and Alvin L. Braswell. *Ambystoma talpoideum*: geographic distribution. SSAR Herp Review 16(1):31. 1985-11
- Potter, Eloise F. Breeding habits, nestling development, and vocalizations in the Summer Tanager. Chat 49:57-65. 1985-12
- Lee, David S. Breeding-season records of boreal birds in western North Carolina with additional information on species summering on Grandfather Mountain. Chat 49:85-94. 1985-13
- Lee, David S., and Mary K. Clark. Atypical nest site for a Prothonotary Warbler. Chat 49:98-99. 1985-14
- Lee, David S. Turtles in North Carolina waters. Pages 1-24 in Empress II Environmental Impact Statement, Vol. I. Department of the Navy, Washington, D.C. 1985-15
- Lee, David S. Marine mammals off the North Carolina coast with particular reference to possible impact of proposed Empress II. Pages 1-30 in Empress II Environmental Impact Statement, Vol. I. Department of the Navy, Washington, D.C. 1985-16
- Lee, David S. Results of a ten year study of marine birds south of the Virginia Cape region: their potential impact with Empress II. Pages 1-80 in Empress II Environmental Impact Statement, Vol. I. the Navy, Washington, D.C. 1985-17

**CONTRIBUTIONS OF THE NORTH CAROLINA BIOLOGICAL SURVEY
AND THE NORTH CAROLINA STATE MUSEUM—1986**

- | | |
|--|---------|
| Plantania, Steven P., Gilbert S. Grant, and David S. Lee. Core temperatures of non-nesting western Atlantic seabirds. <i>Brimleyana</i> 12:13-18. | 1986- 1 |
| Lee, David S. Seasonal, thermal, and zonal distribution of ocean sunfish, <i>Mola mola</i> (Linnaeus), off the North Carolina coast. <i>Brimleyana</i> 12:75-83. | 1986- 2 |
| Shelley, Rowland M., and Donald R. Whitehead. A Reconsideration of the Milliped Genus <i>Sigmoria</i> , with a Revision of <i>Deltotaria</i> and an Analysis of the Genera in the Tribe Apheloriini (Polydesmida: Xystodesmidae). <i>Memoirs of the American Entomological Society</i> 35:1-223. | 1986- 3 |
| Lee, David S. Latitudinal and altitudinal frontiers: summer bird fauna of Grandfather Mountain, North Carolina. (Abstract). Wilson Ornithological Society, Sixty-seventh Annual Meeting. | 1986- 4 |
| Lee, David S. Marine birds, their feeding ecology and commercial fisheries relationships. D. N. Nettleship, G. A. Sanger, and P. F. Springer, editors. (Review). <i>Wilson Bulletin</i> 98:327. | 1986- 5 |
| Lee, David S., and Gilbert S. Grant. An albino greater shearwater: feather abrasion and flight energetics. <i>Wilson Bulletin</i> 98:488-490. | 1986- 6 |
| Watson, George E., David S. Lee, and Edward S. Backus. Status and subspecific identity of White-faced Storm-Petrels in the western North Atlantic. <i>American Birds</i> 40:401-408. | 1986- 7 |
| Lee, David S. Seasonal distribution of marine birds in North Carolina waters, 1975-1986. <i>American Birds</i> 40:409-412. | 1986- 8 |
| Lee, David S. Transient spring warblers in the Maryland piedmont: the explosive nature of migration. <i>American Birds</i> 40:542-545. | 1986- 9 |
| Potter, Eloise F. H. H. and C. S. Brimley: brother naturalists. <i>Chat</i> 50:1-9. | 1986-10 |
| Sykes, Paul W., Jr. Autumn Land-bird Migration on the Barrier Islands of Northeastern North Carolina. | 1986-11 |
| Lee, David S., and Eloise F. Potter. Checklist of North Carolina Birds, 1986. 4 pages. | 1986-12 |
| Lee, David S. An overview of the breeding bird fauna of pocosins and associated communities. <i>American Birds</i> 40:1263-1273. | 1986-13 |
| Potter, Eloise F. The first fifty years: a brief history of Carolina Bird Club. <i>Chat</i> 50:61-95. | 1986-14 |
| Potter, Eloise F. Charlotte Hilton Green. <i>Chat</i> 50:111-116. | 1986-15 |
| Lee, David S. Second record of the Cape Petrel in the western North Atlantic. <i>Chat</i> 50:118-119. | 1986-16 |
| Braswell, Alvin L. Geographic distribution: <i>Sternotherus minor peltifer</i> . <i>SSAR Herp Review</i> 17(3):67. | 1986-17 |
| Wiley, John E., and Alvin L. Braswell. A triploid male <i>Rana palustris</i> . <i>Copeia</i> 1986(2):531-533. | 1986-18 |
| McAllister, D. E., S. P. Platania, F. W. Schueler, M. E. Badwin, and D. S. Lee. Ichthyofauna patterns on a geographic grid. Pages 17-51 in <i>The Zoogeography of North American Freshwater Fishes</i> . C. H. Hocutt and E. O. Wiley, editors. John Wiley and Sons, Inc., New York. | 1986-19 |

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